BL

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

UNCLASSIFIED

REPORT NO. 7-45

EXAMINATION OF ITALIAN PROJECTILES

47mm A.P. PROJECTILE
47mm H.E. PROJECTILE
105mm H.E. PROJECTILE
120mm COMMON PROJECTILE
149mm H.E. PROJECTILE
6" H.E. PROJECTILE
6" COMMON PROJECTILE

July 1945

NOTICE OF CHANGE IN CLASSIFICATION
OPNAV FORM-5511-11 (4-56) S/N 0107-786-1000

COMMANDER
NAVAL SURFACE WEAPONS CENTER
DAHLGREN LABORATORY
DAHLGREN, VIRGINIA 22448

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NPG Report No. 7-45, July 1945, Subj: Examination of Italian Projectiles(U)

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6" COMMON PROJECTILE

INDEXED

DESCRIPTIVE

CLASSIFICATION [redacted] (CHANGED TO) UNCLASSIFIED BY AUTHORITY OF (SIGNATURE) (RANK) ON 3-10-76 (DATE)

APPROVED:

K. M. MCLAREN

CAPTAIN, U. S. N.

ACTING COMMANDING OFFICER

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AUTHORIZATION

Specific directives for these investigations were issued in BuOrd ltr. EF 74(Re3) dated 23 December 1944 and BuOrd ltr. EF 74(Re3) dated 26 February 1945.

OBJECT

To make a complete physical, chemical and metallurgical examination of the following Italian projectiles.

47mm A.P. Projectile
47mm H.E. Projectile
105mm H.E. Projectile
120mm Common Projectile
149mm H.E. Projectile
6" H.E. Projectile
6" Common Projectile

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VII	EXAMINATION AND BALLISTIC TESTS OF ITALIAN 6" COMMON PROJECTILES

I

EXAMINATION OF ONE ITALIAN 47mm. A.P. PROJECTILE CEE NO. 3662

SUMMARY

This projectile was made from nickel, chromium, silicon steel. It was forged and machined, then heated uniformly and quenched and drawn. The base was drawn in a separate operation to a low hardness.- A hardness survey of the entire projectile was made.

The chemical analyses and microstructure of all the projectile components are given.

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Figure 1

NPG Photo No. 2270 (APL)
As received and disassembled view of Italian 47mm A.P. round. CEE No. 3662.
15 May 1945

[redacted]

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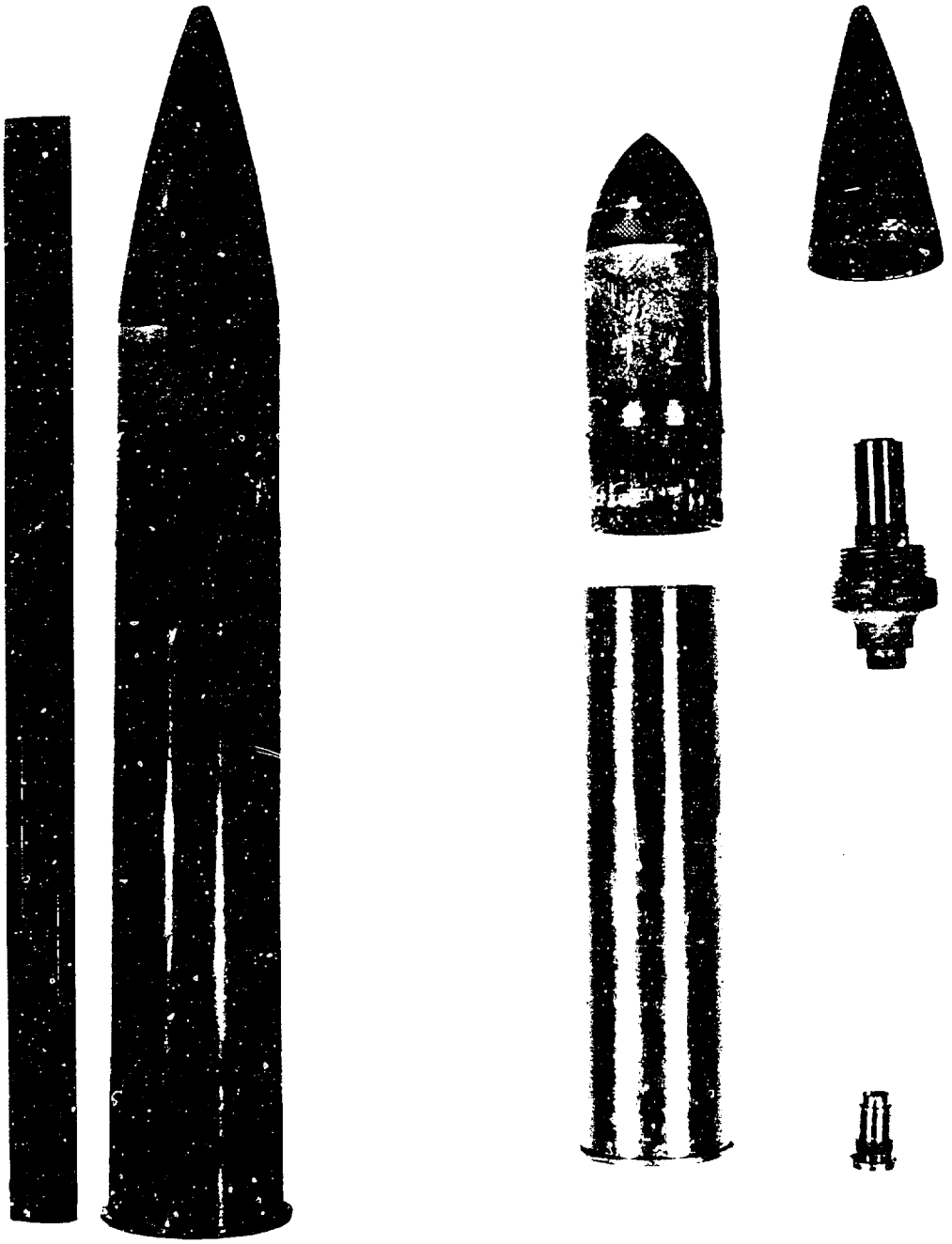

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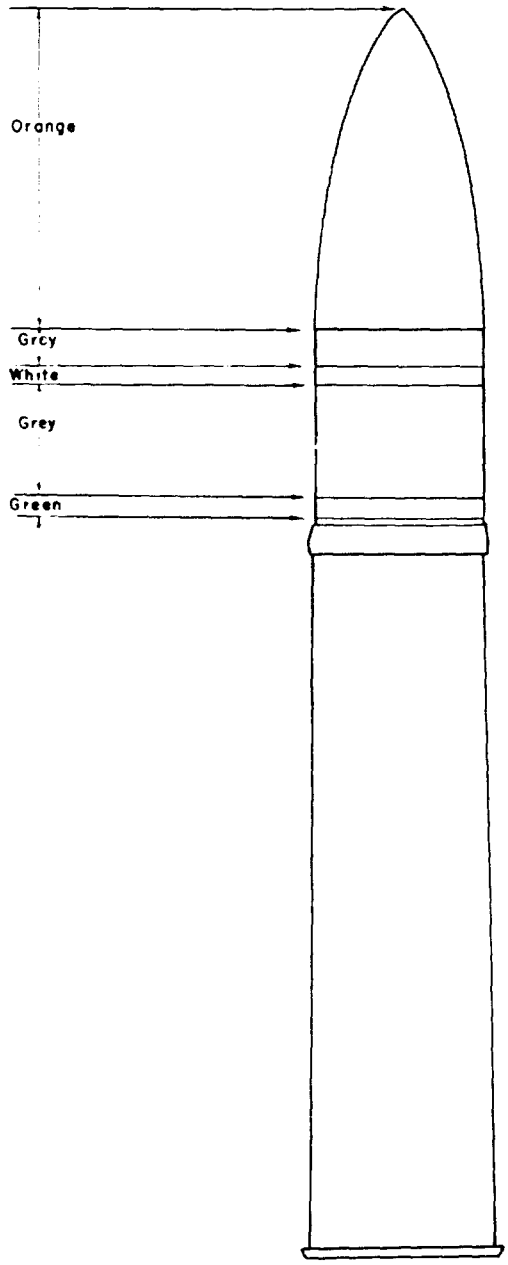
Figure 2

MARKINGS ON ITALIAN 47mm AP PROJECTILE AND CASE

UNCLASSIFIED

CEE 3662



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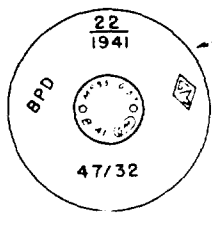

All Markings Stamped

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NPG Photo No 2548 (APL)
May 15, 1945

I. INTRODUCTION

One Italian 47mm A.P. round was received at the Naval Proving Ground for complete physical, chemical and metallurgical examination. The following is a report of this investigation in accordance with the directives.

II. EXAMINATION

PHYSICAL

The complete round, as received and disassembled is shown in Figure 1. The projectile is provided with a windshield which is crimped to the nose and with a base plug carrying a base detonating fuze and tracer. The markings found on the round are reproduced in Figure 2. These markings show that the case was manufactured in 1941 but give no indication as to the date of manufacture of the projectile. Colors used to identify the projectile and its loading are also shown in Figure 2.

CHEMICAL

Chemical analyses of the projectile components are given in the following table. Steel analyses are spectrochemical excepting carbon, phosphorus and sulphur which have been obtained by standard wet chemical methods.

	C	Mn	P	S	Si	Ni	Cr	Mo	Cu	Al
Windshield	.07	.35	.007	.036	NTr	<.08	NTr	.02	Tr	Tr
Body	.50	.53	.027	.022	1.23	.62	.80	.02	.18	NTr
Base Plug	.36	.62	.015	.014	.29	<.08	NTr	<.005	Tr	NTr

	Cu	Zn	Sn	Fe	P
Band	99.78	.035	.035	.120	.024

Tr = Trace NTr = No Trace

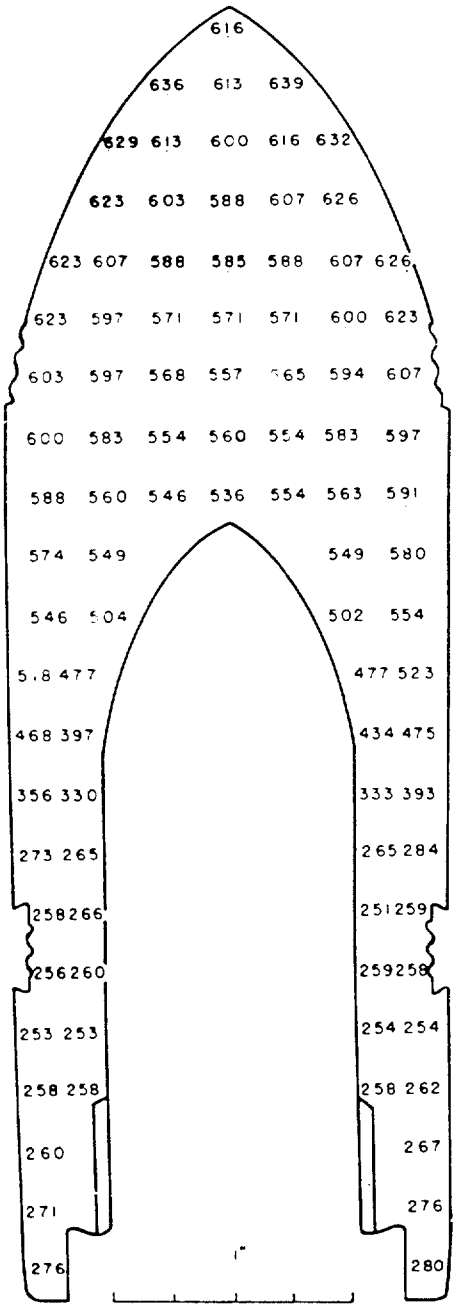
The windshield has been fabricated from a low carbon rimmed steel of the type commonly used for the manufacture of thin sheet to be used for deep drawing. A nickel, chromium, silicon steel has been used for the body of the projectile and the base plug is manufactured from a medium carbon steel similar to SAE 1035. The rotating band is copper but is rather impure as compared to American standards for this material.

Figure 3

HARDNESS DISTRIBUTION AND MACROSECTION OF ITALIAN 47mm AP PROJECTILE

Hardness Values: Vickers Pyramid (50 Kg.)
Etch: Ammonium Persulphate

CEE 3662



Scale

NPG Photo No. 2546 (APL)
May 15, 1945

Figure 4

MICROSTRUCTURES OF
ITALIAN 47mm AP PROJECTILE

PROJECTILE NOSE Martensite with Bainite Needles

Hardness - 610 VPN
Magnification - 1000X
Etch - Picral Nital
M489

PROJECTILE BASE Tempered Martensite

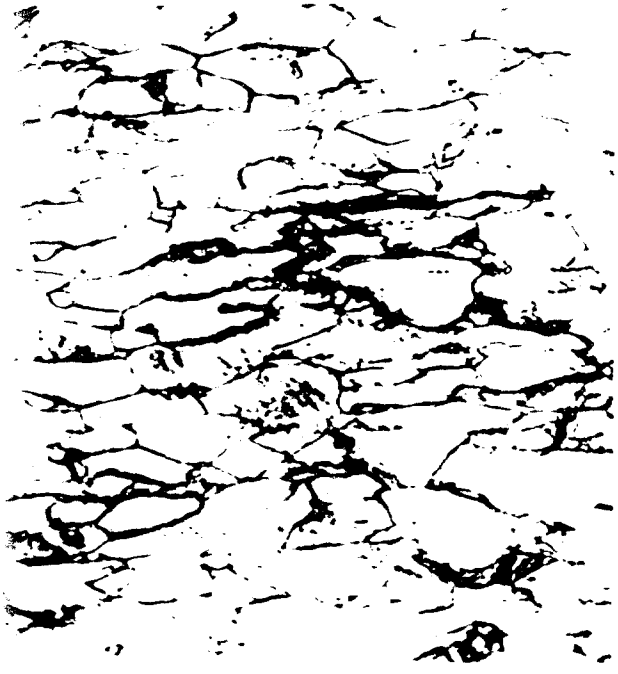
Hardness - 260 VPN
Magnification - 1000X
Etch - Picral Nital
M490

NPG Photo No. 2649 (APL)
15 June 1945

[redacted]

Figure 5

MICROSTRUCTURES OF
ITALIAN 47mm AP PROJECTILE



WINDSHIELD Ferrite

Hardness - 79 Rb
Magnification - 250X
Etch - Nital
M492

BASE PLUG Pearlite and Ferrite

Hardness - 85 Rb
Magnification - 250X
Etch - Picral
M491

NPG Photo No. 2650 (AFL)
15 June 1945

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METALLURGICAL

The projectile body was split longitudinally with an abrasive cut-off wheel and a hardness survey made of the entire cross-section. Figure 3 shows the hardness distribution and macro-etch section of the body. A maximum hardness of approximately 630 VPN (56Rc) has been obtained on the nose of the projectile. The hardness drops off slowly from the nose to a point about a quarter of an inch above the band score where it drops off rapidly to approximately 260 VPN (25Rc) which hardness is maintained throughout the base. The flow lines shown in the macro-etch section indicate that the projectile was forged and machined.

The microstructure of the nose and base of the projectile are shown in Figure 4. Both structures were produced by a normal quench and temper operation, the nose consisting of martensite and bainite and the base, tempered martensite. The microstructures of the other components of the projectile are shown in Figure 5. The windshield is seen to consist of ferrite with perhaps a slight trace of pearlite, while the base plug has a normalized structure of pearlite and ferrite. The hardness of these two components was found to be as follows:

Windshield - - - -	79 Rb
Base Plug - - - -	85 Rb

III. DISCUSSION

The maximum nose hardness of this 47mm projectile is somewhat lower than the nose hardness of American projectiles of this caliber. The American 37mm and 40mm AP projectiles generally have a nose hardness of from 700 to 750 VPN (60 to 62 Rc), as compared to approximately 630 VPN (56Rc) for the subject projectile.

An examination of the photomicrographs and etch section of this projectile indicate that it was probably heat treated in the following manner.

(a) Heated uniformly to above its critical temperature and quenched

(b) Drawn at a temperature to produce a hardness of approximately 630 VPN (56Rc)

(c) Base drawn in lead at a temperature between 1100 and 1200° F.

II

EXAMINATION OF ONE ITALIAN 47mm H.E. PROJECTILE CEE NO. 3662

SUMMARY

The projectile body was machined from a sulphur bearing plain carbon steel. It was given a single normalizing heat treatment, and has a uniform hardness of approximately 92 R_B.

The chemical composition and microstructure of the projectile are given.

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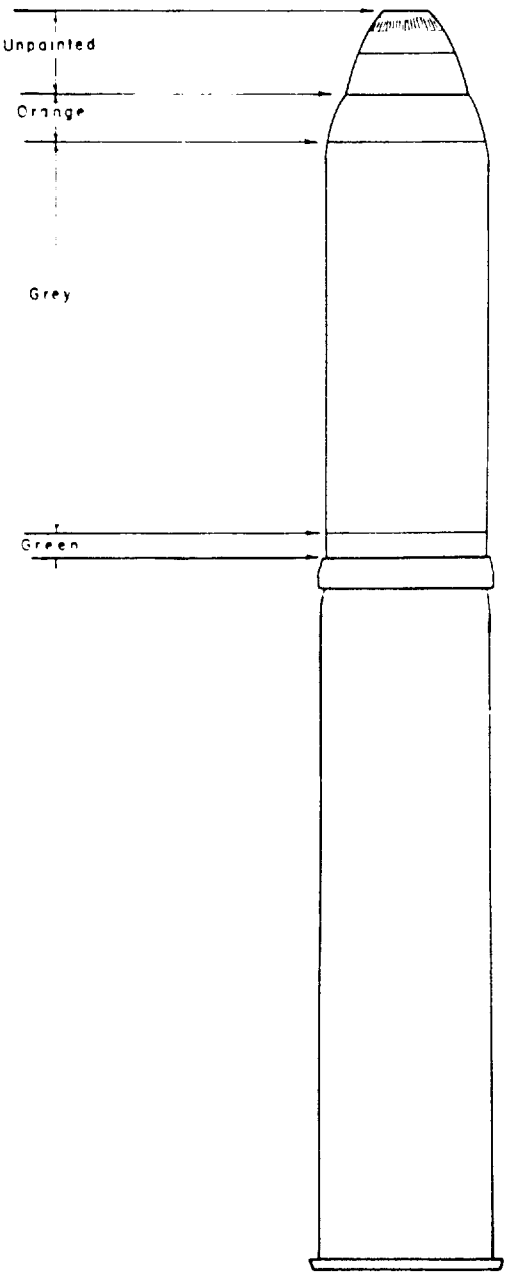
Figure 1

NFG Photo No. 1350 (APL).
As received and disassembled view of Italian 47mm H.E. round. CER No. 3662.
15 May 1945

Figure 2

MARKINGS ON ITALIAN 47mm HE PROJECTILE

CEE 3662



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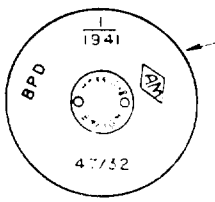


All Markings Stamped

NPG Photo No 2443 (APL)
May 15, 1945

Figure 3

NPG PHOTO NO. 2594 (APL)
Deep etched section of Italian 47mm H.E. projectile.
CEE No. 3662.
15 May 1945

[redacted]

UNCLASSIFIED

NPG Photo No. 2651 (APL)

UNCLASSIFIED

Figure 4

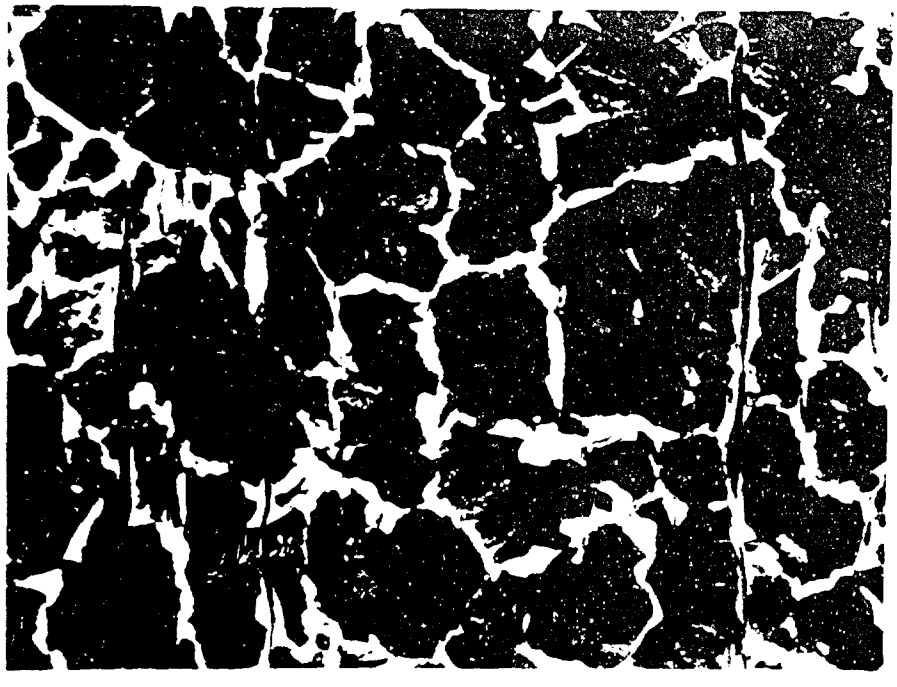
MICROSTRUCTURE OF THE BODY OF ITALIAN 47mm HE PROJECTILE

Fine Pearlite and Ferrite

Hardness - 92 Rb Magnification 250X

Etch - Picral M493

15 June 1945



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I. INTRODUCTION

One Italian 47mm H.E. round was received at the Naval Proving Ground for complete physical, chemical, and metallurgical examination. The following is a report of this investigation in accordance with the directives.

II. EXAMINATION

PHYSICAL

The complete round, as received and disassembled, is shown in Figure 1-. The projectile extends into the case nearly half its length, and is fitted with a narrow rotating band near its center. A contact type nose fuze is provided. The markings found on the round are shown in Figure 2 and indicate that the case was manufactured in 1941, but give no indication as to the date of manufacture of the projectile. The colors used to identify the projectile and its loading are also given in Figure 2.

CHEMICAL

A chemical analysis of the projectile body and rotating band is given in the table below. Steel analyses are spectrochemical with the exception of carbon, phosphorus, and sulphur which have been obtained by standard wet chemical methods.

	C	Mn	P	S	Si	Ni	Cr	Mo	Cu	Al
Body	.56	.82	.022	.080	.18	<.08	NTr	NTr	.11	NTr

	Cu	Zn	Sn	Fe	P
Band	99.87	None	None	.091	.043

NTr = No trace

The projectile has been machined from a plain carbon steel with an analysis similar to SAE 1055. Attention is invited to the high sulphur content of this steel probably added for increased machinability. The rotating band is copper.

METALLURGICAL

The projectile body was split longitudinally and deep etched to reveal the flow lines. Figure 3 shows the etched section and indicates that the projectile was machined from bar stock. A uniform hardness of approximately 92 Rb was obtained along the surface of the body. The microstructure of the projectile body is shown in Figure 4. It consists of fine pearlite and ferrite and has a relatively large number of non-metallic inclusions.

DISCUSSION

The subject projectile body was manufactured from a plain carbon steel. It was machined from bar stock and was given a single heat treatment probably consisting of an air cool from above the critical temperature.

III

EXAMINATION OF ONE ITALIAN 105mm H.E. PROJECTILE CEE NO. 3651

SUMMARY

This projectile was produced by piercing and forging. It was made from a high manganese, free machining steel similar to SAE x 1345. The chemical analysis of the projectile and its components are given.

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Figure 1

NPG Photo No. 1404 (APL)
As received and disassembled view of Italian 105mm H. E. projectile. CEE No. 3651.
15 May 1945

[redacted]

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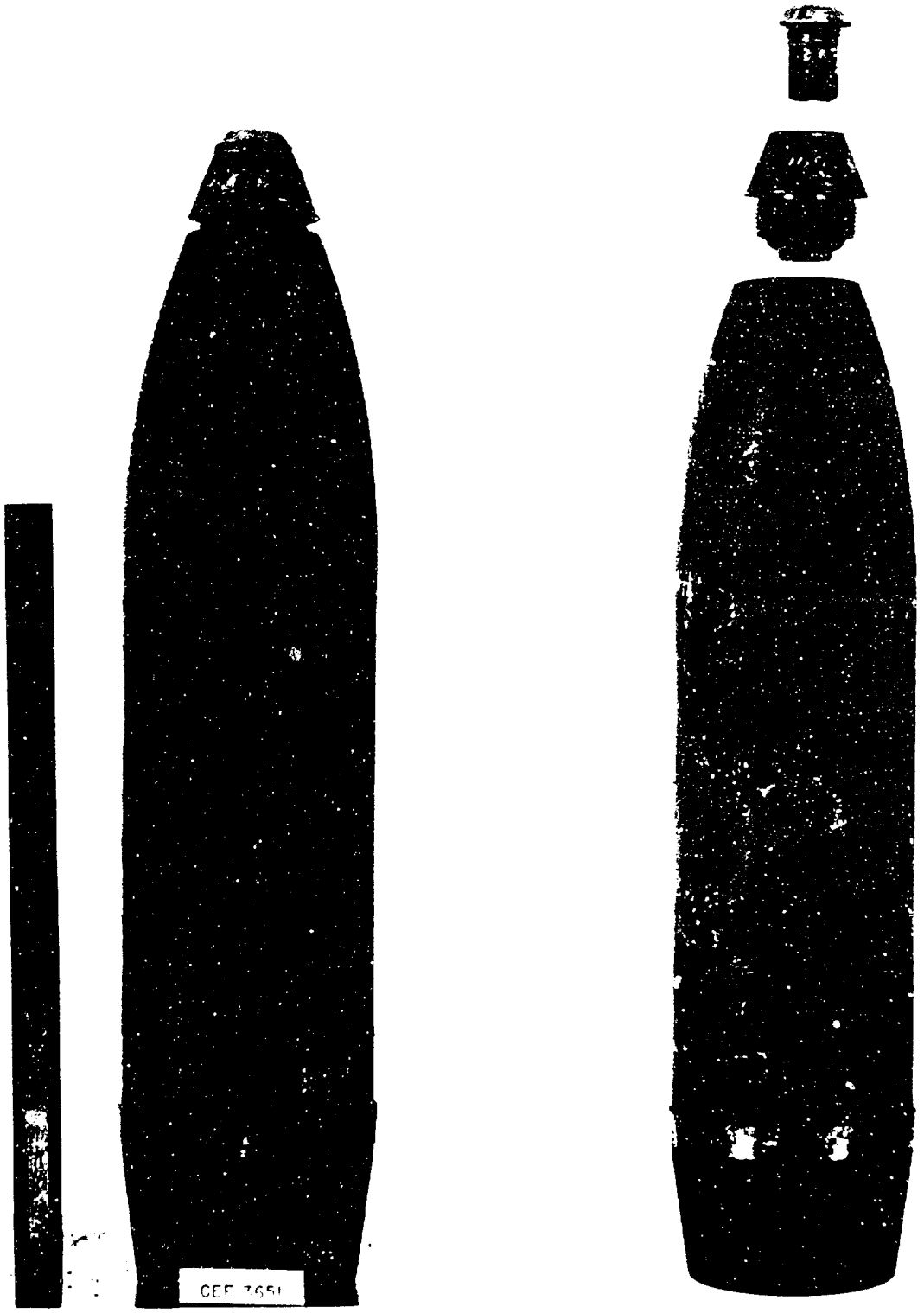
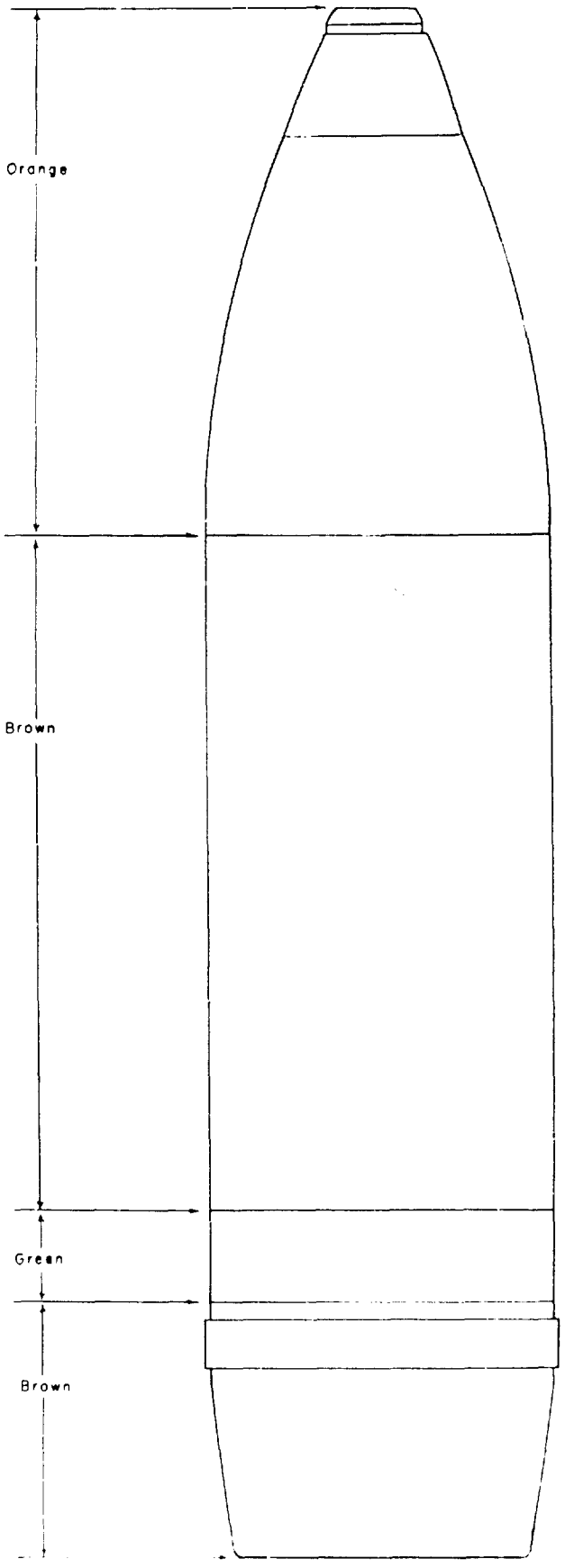


ASSIFIED

MARKINGS ON ITALIAN 105mm HE PROJECTILE

CEE 3651



Indistinct Stenciling
MIGL 98

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R.B.-X
105/78

NPG Photo No 2550 (APL)

Figure 3

NPG PHOTO NO. 2555 (AFL)
Deep etched section of Italian 105mm H.E. projectile.
CEE No. 3651.
15 May 1945

I. INTRODUCTION

One Italian 105mm H.E. projectile was received at the Naval Proving Ground for complete physical, chemical and metallurgical examination. The following is a report of this investigation in accordance with the directives.

II. EXAMINATION

PHYSICAL

Figure 1 shows the projectile as received and disassembled. A nose plug is provided with a threaded hole in the end for a detonating fuze. The projectile was received with a shipping plug screwed into the fuze hole.- The markings found on the projectile and its identifying coloring are shown in the drawing of Figure 2. There is no opening in the base of the projectile and only a very narrow rotating band is provided.

CHEMICAL

A chemical analysis of the projectile body and its components is given in the table below. Steel analyses are spectrochemical excepting carbon, phosphorus and sulphur which have been obtained by standard wet chemical methods.

Nose	C	Mn	P	S	Si	Ni	Cr	Mo	Cu
Plug	.29	.90	.044	.074	.20	<.08	NTr	NTr	.18
Body	.48	1.25	.023	.049	.20	.16	<.08	.01	.14

	Cu	Zn	Sn	Fe	P
Band	99.86	.024	.047	.049	.019

NTr = No Trace

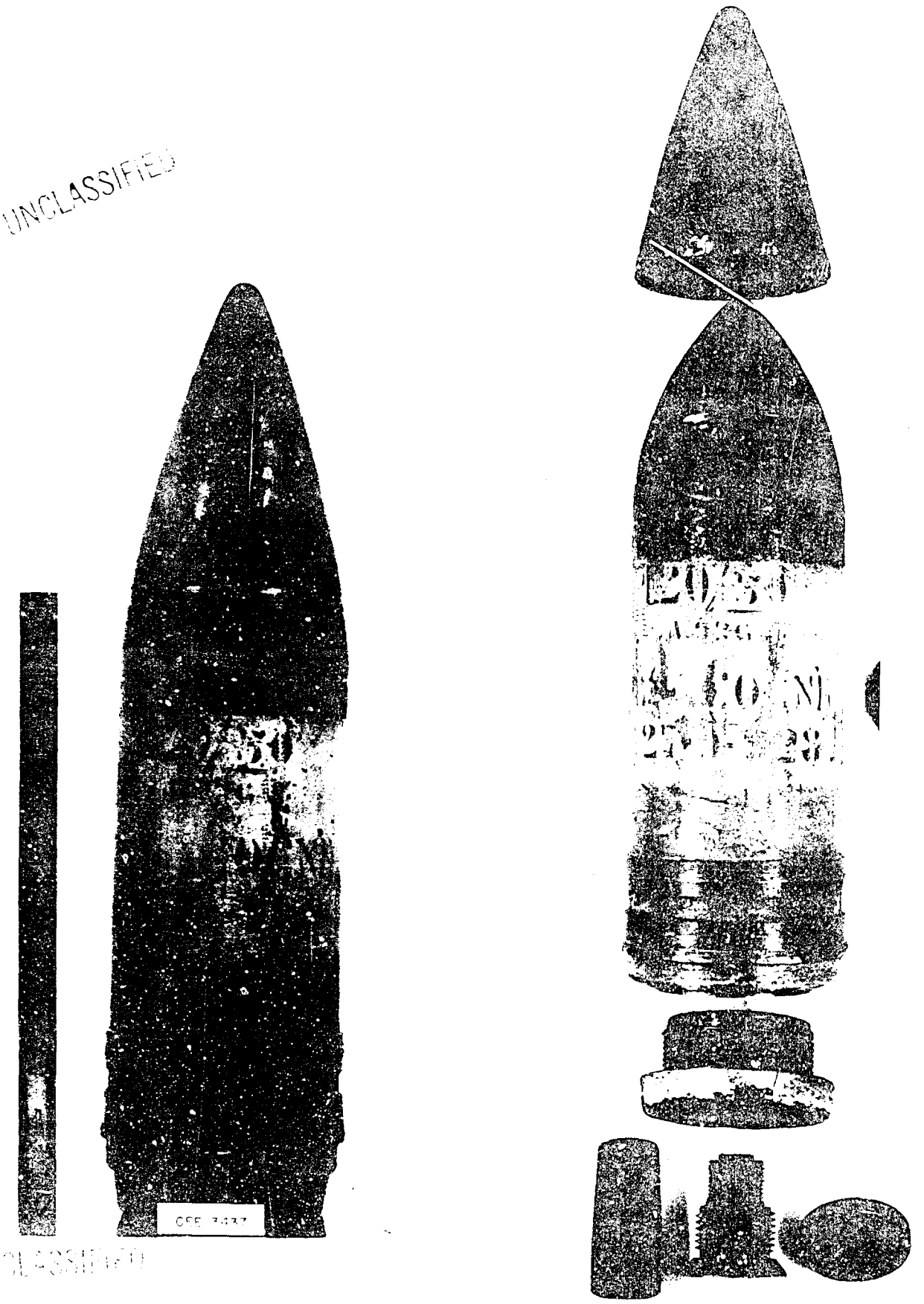
The nose plug was manufactured from a plain carbon steel corresponding to SAE 1030 while the body of the projectile was made from a free machining high manganese steel similar to SAE X 1345. The rotating band is copper.

METALLURGICAL

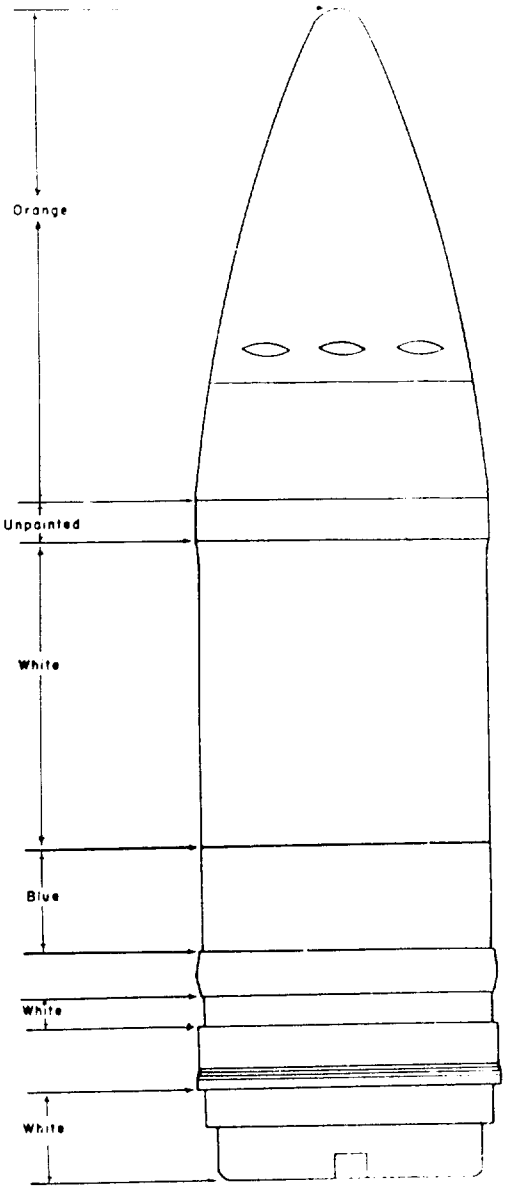
The projectile body was sectioned longitudinally with an abrasive cut-off wheel and deep etched to reveal the flow lines. The deep etched section is shown in Figure 3. The distribution and direction of the flow lines indicate that the projectile was upset forged and pierced to

Figure 1

NPG PHOTO NO. 1852 (APL).
As received and disassembled view of Italian [illegible] Common projectile CEE No. 3437.
15 May 1945



MARKINGS ON ITALIAN
[illegible] COMMON PROJECTILE



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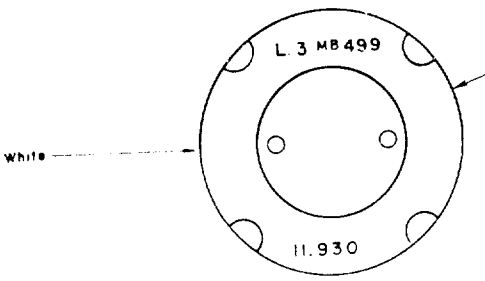

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NPG Photo No 2442 (APL)

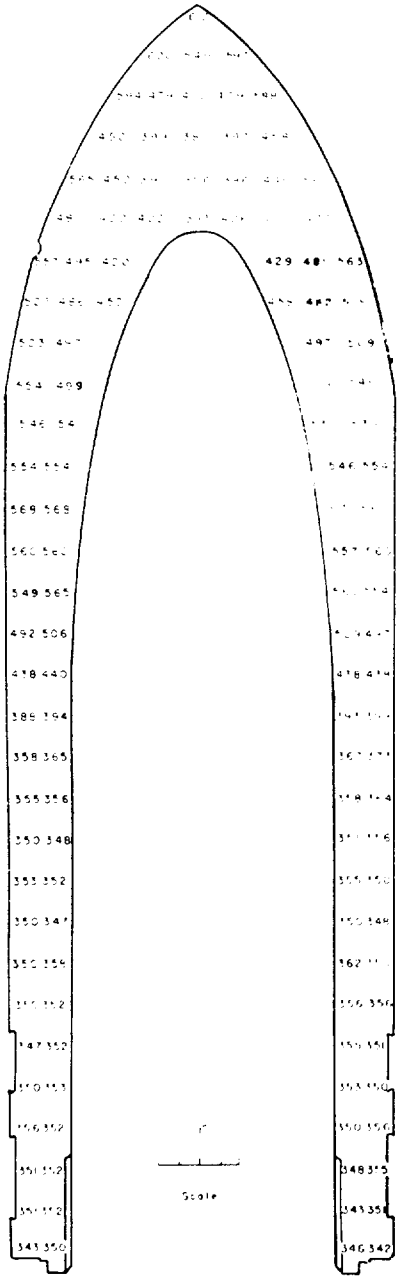
May 15, 1945

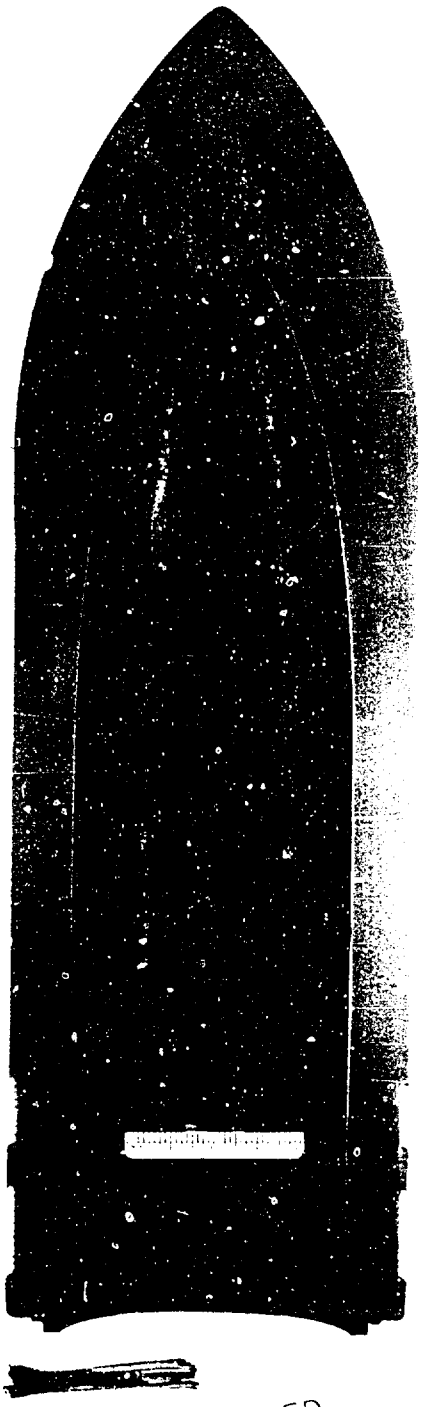
Figure 5

HARDNESS DISTRIBUTION AND MACROSECTION OF ITALIAN 120mm COMMON PROJECTILE

Hardness Values Vickers Pyramid (50Kg)
Etch Ammonium Persulphate

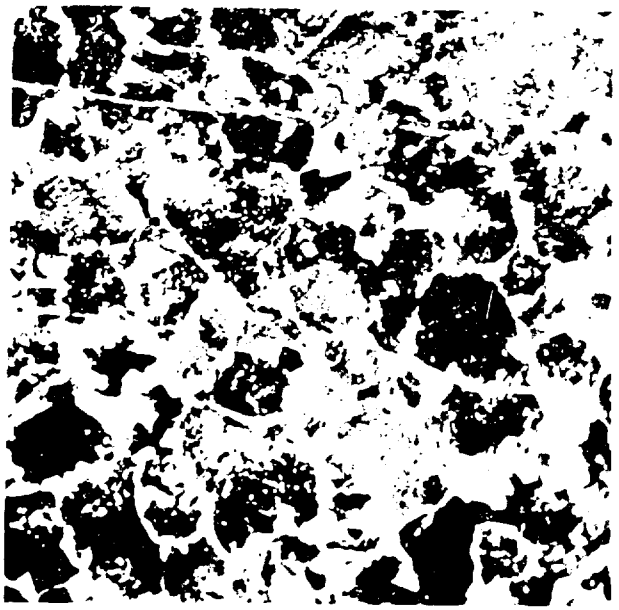
CEE 5437





NPG Photo No. 2551 (APL)
May 15, 1945

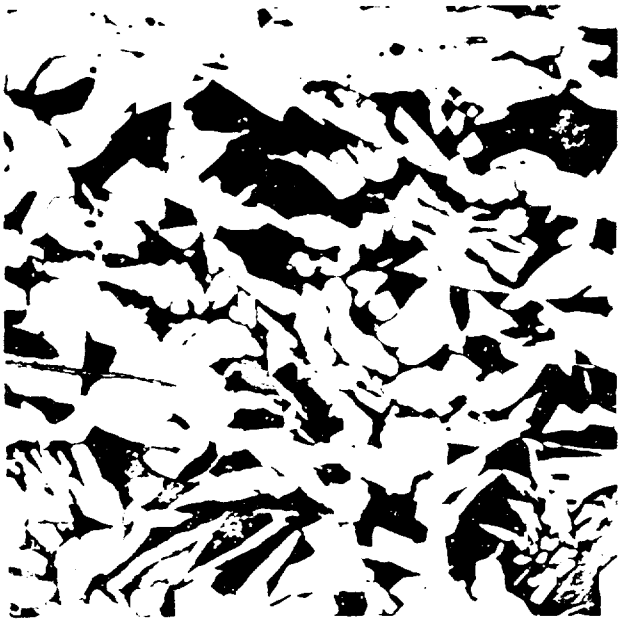
Figure 4



MICROSTRUCTURES OF
ITALIAN 105mm HE PROJECTILE

BODY Pearlite and
Ferrite

Hardness - 99 Rb
Magnification - 250X
Etch - Picral
M499



NOSE PLUG Pearlite and
Ferrite

Hardness - 78 Rb
Magnification - 250X
Etch - Picral
M498

NPG Photo No. 2652 (APL)
15 June 1945

[redacted]

IV

EXAMINATION OF ONE ITALIAN 120mm COMMON PROJECTILE CEE NO. 3437

SUMMARY

This projectile was manufactured from a 0.47% carbon nickel-chrome steel by a forging operation. It was uniformly hardened and then base drawn. The complete hardness pattern is given and the chemical composition of all its components was determined.

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Fig. 5	NPG Photo No. 2653 (APL) Microstructures . .	2
Fig. 6	NPG Photo No. 2654 (APL) Microstructures . .	2

form the cavity. The nose was shaped by forging and then finish machined. A hardness of approximately 99 Rb was obtained on the surface of the projectile body. In Figure 4 is shown the microstructure of the nose plug and body, both consist of ferrite and pearlite, the amount of pearlite present being in proportion to the carbon content of the steel. The nose plug had a uniform hardness of 78 Rb.

III DISCUSSION

A high manganese, free machining, steel has been used in the manufacture of this projectile. It has been manufactured by forging and piercing and has not received any special heat treatment. The microstructure indicates that it was normalized by heating to above the critical temperature and cooling in air. The microstructure, heat treatment and hardness are similar to U.S. Navy projectiles of this type and size.

I. INTRODUCTION

One Italian 120mm Common projectile was received at the Naval Proving Ground for complete physical, chemical and metallurgical examination. The following is a report of this investigation in accordance with the directives.

II. EXAMINATION

PHYSICAL

Figure 1 shows the projectile as received and disassembled. It is provided with a windshield crimped to the ogive, a base plug and base detonating fuze. Two rotating bands are used. The markings found on the projectile and its identifying colors are given in Figure 2.

CHEMICAL

A chemical analysis of the projectile body and its components is given in the table below. Steel analyses are spectrochemical excepting carbon, phosphorus and sulphur which have been obtained by standard wet chemical methods.

	C	Mn	P	S	Si	Ni	Cr	Mo	Cu
Windshield	.06	.38	.005	.032	NTr	<.08	NTr	NTr	.18
Body	.45	.51	.032	.014	.78	.55	.81	NTr	.18
Base Plug	.47	.54	.030	.024	.25	<.08	NTr	NTr	NTr

	Cu	Zn	Fe	P
Bands	99.80	.011	.082	.106

NTr = No Trace

The windshield of this projectile has been manufactured from a low carbon rimmed steel similar to that used for thin sheet to be processed by deep drawing. The projectile body is made from a fairly high carbon nickel-chrome steel and the base plug is plain carbon steel similar to SAE 1050. The rotating bands are copper.

METALLURGICAL

The projectile body was sectioned longitudinally with an abrasive cut-off wheel and its hardness distribution determined over the entire cross section Figure 3 shows the results of the hardness survey together with the etched section of the split projectile. A maximum hardness of approximately 600 VPN (55Rc) has been obtained on

Figure 4

NPG PHOTO NO. 2444 (AFL).
Bottom view and deep etched section of base plug of Italian 120mm Common projectile CEE No. 3437.
15 May 1945 - [redacted] -

UNCLASSIFIED

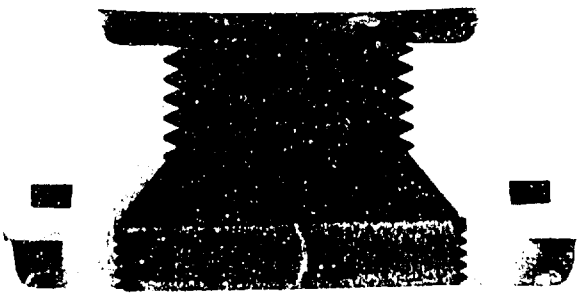

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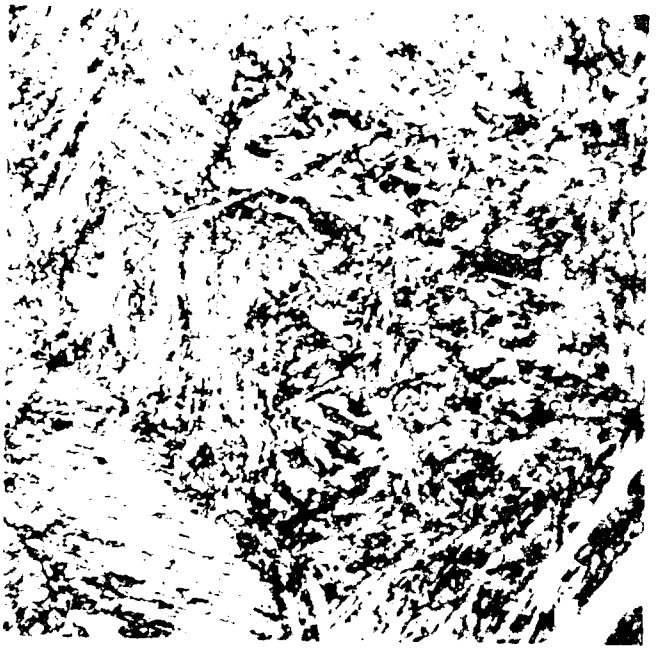
Figure 5

MICROSTRUCTURES OF ITALIAN 120mm COMMON PROJECTILES

PROJECTILE NOSE Martensite with Bainite Needles

Hardness - 600 VPN
Magnification - 1000X
Etch - Picral Nital
M495



PROJECTILE BASE Tempered Martensite

Hardness - 350 VPN
Magnification - 1000X
Etch - Picral
M496

NPG Photo No. 2653 (APL)
25 June 1945

[redacted]

Figure 6

MICROSTRUCTURES OF ITALIAN 120mm COMMON PROJECTILE

BASE PLUG Spherodized Pearlite

Hardness - 92 Rb
Magnification - 500X
Etch - Picral
M497

WINDSHIELD Ferrite and Traces of Pearlite

Hardness - 68 Rb
Magnification - 250X
Etch - Nital
M494

NPG Photo No. 2654 (APL)
15 June 1945

[redacted]

UNCLASSIFIED

the nose of the projectile. The hardness drops off uniformly from the nose to the middle of the body at which point it levels off at about 350 VPN (36Rc). Flow lines in the etch section indicate that the projectile was produced by a forging operation. In Figure 4 is shown a bottom view and deep etched section of the base plug, which also has been produced by forging. The cap seen covering the fuze hole has been machined from bar stock as indicated by the straight flow lines running through it. The base plug had a uniform hardness of 92 Rb.

Photomicrographs of the projectile body are given in Figure 5. Both the nose and base are quenched and tempered structures consisting of carbides and tempered martensite. The microstructure of the base plug and wind-shield are shown in Figure 6. The base plug has a structure consisting of spheroidized pearlite and the windshield is largely ferrite with traces of pearlite.

III DISCUSSION

This projectile has been forged from a fairly high carbon nickel-chrome steel. A maximum hardness of approximately 600 VPN (55Rc) has been obtained on the nose and the base has a uniform hardness of approximately 350 VPN (36Rc). It is interesting to note that the nose hardness is practically the same as that of the U.S. Navy 5" common projectile Mk. 46 but the base is somewhat harder. The Mk. 46 has a base hardness of between 280 and 300 VPN (27.5 to 30Rc).

From the photomicrographs and etch section it appears that this projectile has been heat treated to a uniform hardness of 600 VPN and then base drawn. It is probable that it would have fairly good plate penetrative qualities for the size of cavity used.

V

EXAMINATION OF ONE ITALIAN 149mm H.E. PROJECTILE CEE NO. 3648

SUMMARY

Metallurgical data and chemical analyses of the principal components of this projectile are presented together with the probable method of manufacture of the body and nose piece.

The nature of the cavity indicates that this projectile is a chemical type.

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Fig. 4	NPG Photo No. 2666 (APL) Photomicrographs. . .	2

FIGURE 1

NPG Photo No. 2793 (APL).
As received and disassembled view of Italian 149mm H.E. projectile. CEE No. 3648.
15 May 1945

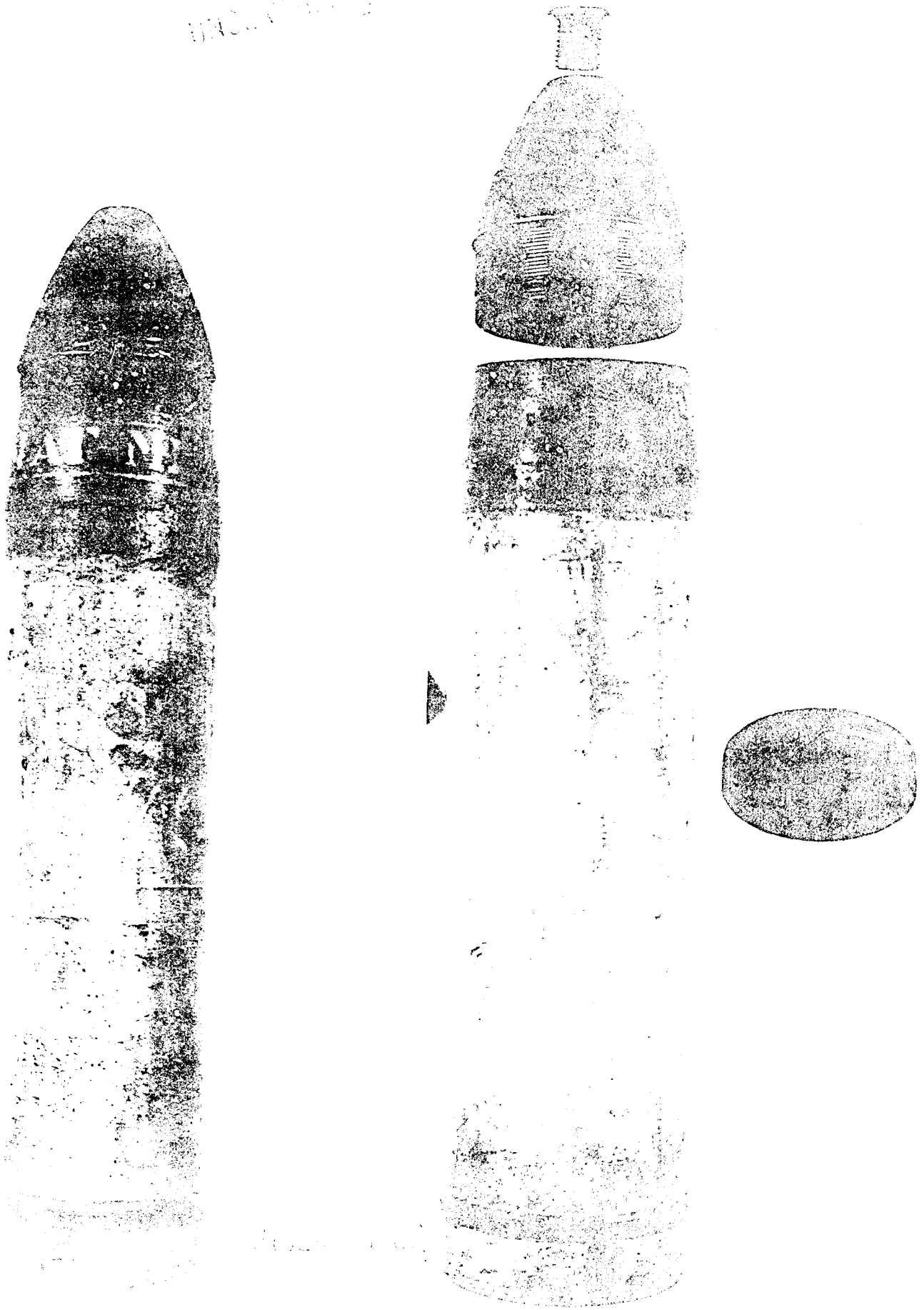
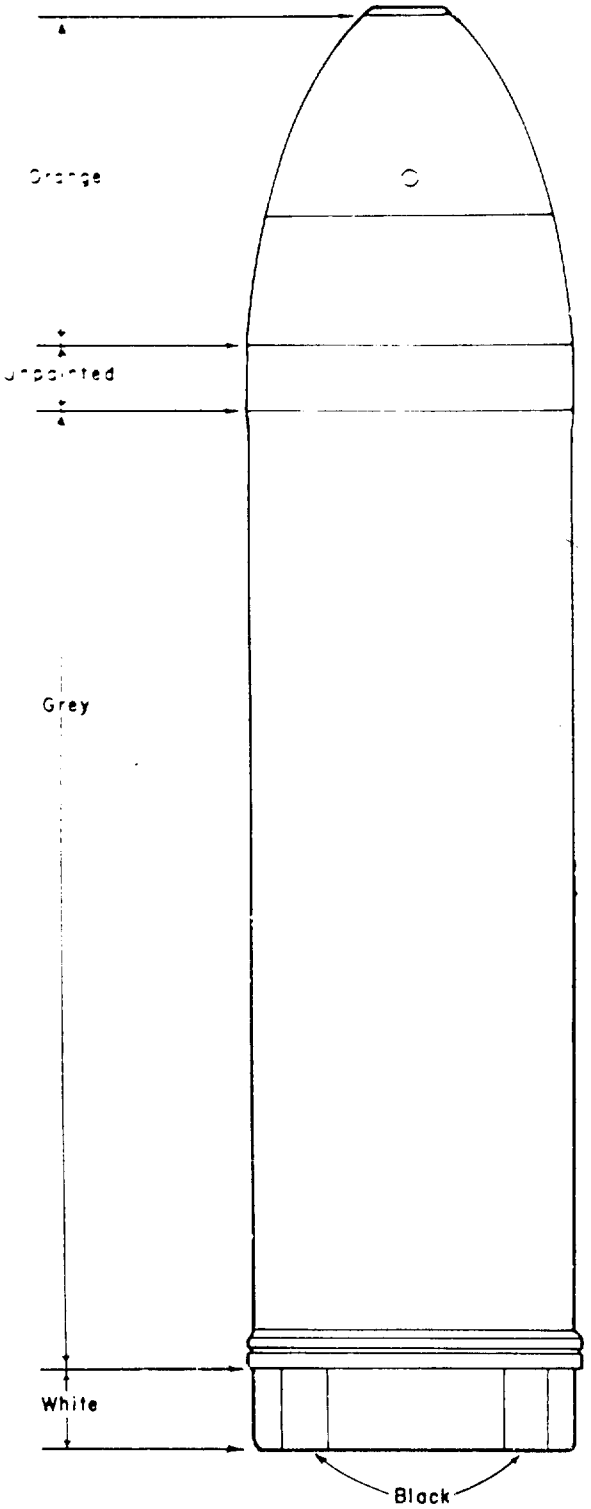


FIGURE 2

MARKINGS ON ITALIAN 149 mm HE PROJECTILE

CEE 3648



NPG Photo No. 2549 (APL)
May 15, 1945

[redacted]

Figure 3

NPG Photo No. 2596 (APL).
Deep etched section of Italian 149mm H.E. projectile.
CEE No. 3648.
15 May 1945

[redacted]

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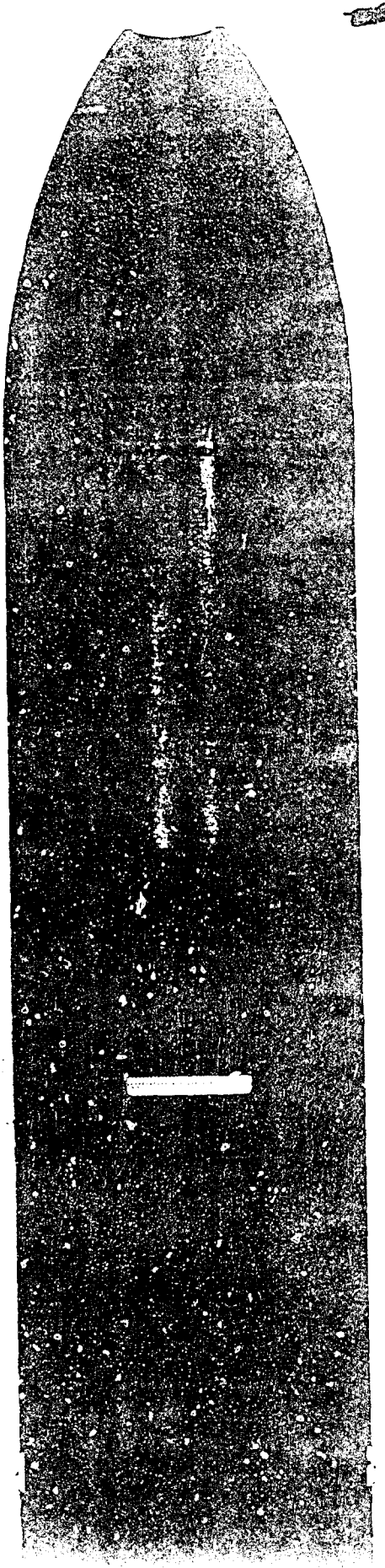


UNCLASSIFIED

I. INTRODUCTION

One Italian high explosive 149mm projectile was examined in accordance with the directive. A report of the examination follows.

II. EXAMINATION

PHYSICAL

Figure 1 shows the projectile as received and disassembled. The projectile body has a large cavity which is divided about midway by a transverse threaded steel disk having 4 vent holes. This construction suggests that the projectile carried a dual loading, the forward charge as a burster and the rear charge as a smoke, incendiary, or gas filling. The body is threaded at the forward end to take a large nose piece which is itself threaded to provide for a nose fuze.

A single narrow rotating band was attached in the usual way. Figure 2 shows the details of painting and marking.

CHEMICAL ANALYSIS

The chemical analyses of the important components are given below. Steel analyses are spectrochemical, except for the elements carbon phosphorus, and sulfur which were obtained by the usual wet chemical methods.

	C	Mn	P	S	Si	Ni	Cr	Mo	Cu
Body	.73	.94	.034	.074	.08	.13	<.08	NTr	.18
Nose	.48	.59	.088	.053	.17	NTr	NTr	NTr	.08

	Cu	Sn	Zn	Fe
Band	99.91	.030	.032	.017

The body is made of a steel similar to SAE 1075 with high sulfur content, and the nose is made of a steel similar to SAE 1045 with high phosphorus content. The copper of the rotating band is of high purity.

The etch pattern of the nose section and of the body are shown in Figure 3. Flow lines indicate that the body was pierced and the nose section forged.

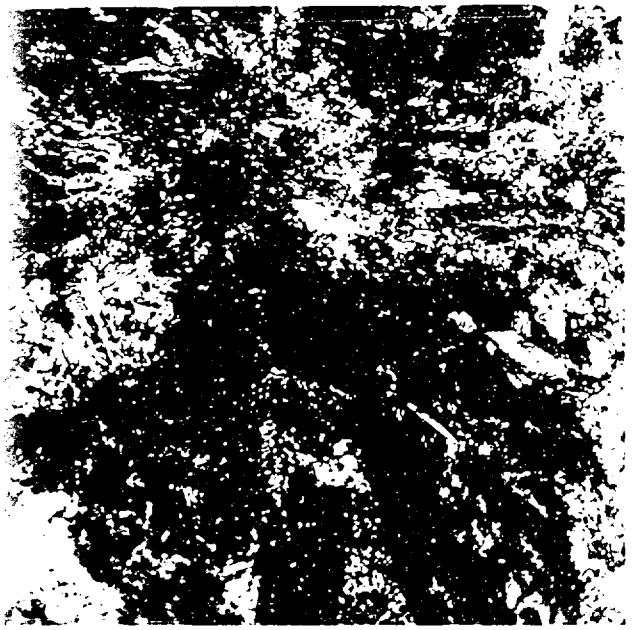
Both body and the nose section were uniform in hardness.

Nose Hardness 94 Rockwell "B"

Body Hardness 98 Rockwell "B"

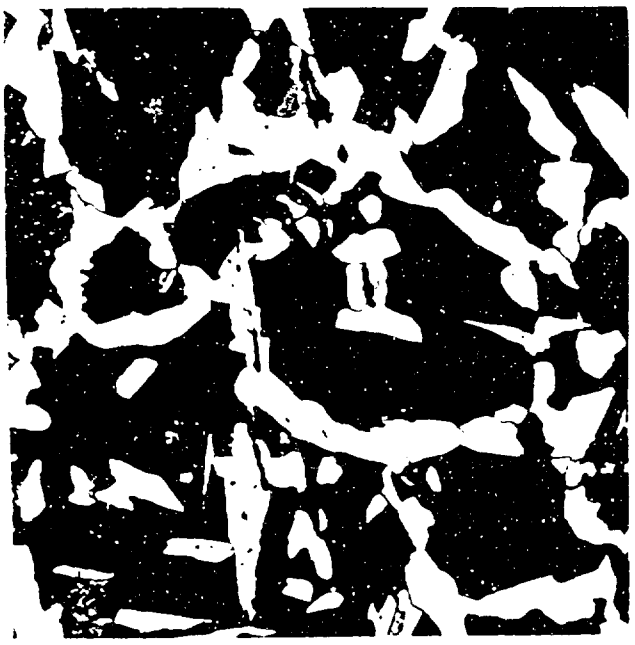
Figure 4

MICROSTRUCTURES OF
ITALIAN 149mm HE PROJECTILE



BODY Pearlite

Hardness - 98 Rb
Magnification - 250X
Etch - Picral
M500



NOSE SECTION Pearlite and Ferrite

Hardness - 94 Rb
Magnification - 250X
Etch - Picral
M501

NPG Photo No. 2666 (APL)
15 June 1945

The microstructure of the nose and body are shown in Figure 4. Both nose and body are normalized structures, the microstructure of the body consisting of pearlite, and that of the nose consisting of pearlite and ferrite.

The probable steps in the manufacture of this projectile are given below:

Body	a.	Piercing
	b.	Normalizing
	c.	Machining
Nose	a.	Forging
	b.	Normalizing
	c.	Machining

III. DISCUSSION

This projectile was probably satisfactory for its intended purpose. The prime consideration in its heat treatment was machinability. The exact nature of the loading is unknown, but it was probably of the chemical type, smoke, incendiary or gas.

VI

EXAMINATION OF ONE ITALIAN 6" H.E. PROJECTILE CEE NO. 3435

SUMMARY

Metallurgical data and chemical analyses of the principal components of this projectile are presented together with the probable methods of manufacture of the body and base plug.

The projectile body and base plug are made of plain carbon steel.

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Fig. 5	NPG Photo No. 2564 (APL) Microstructure	2

Table A: Chemical Analyses

Table A UNCLASSIFIED

CHEMICAL ANALYSES OF ITALIAN 6" H.E. COMPONENTS

	C	P	S	Si	Mn	Ni	Cr	Cu
Projectile Body:	.35	.013	.033	.21	.69	--	<.08	.20
Base Plug:	.54	.032	.051	.12	.57	<.08	--	.19

	Si	Fe	Cu	Mn	Zn	Ti	Trace	Balance
Windshield:	12.19	1.31	.19	.075	.075	.29	Mg,Pb	Al.

	Cu	P	Fe	Zn
Rotating Band:	99.81	.124	.041	.025

	Pb	Sn	Trace
Sealing Ring:	99.92	.052	Sb,Bi,Ag.

UNCLASSIFIED

Italian 6" HE Projectile, CEE No.3435, as Received and Disassembled View.
15 May 1945

[redacted]

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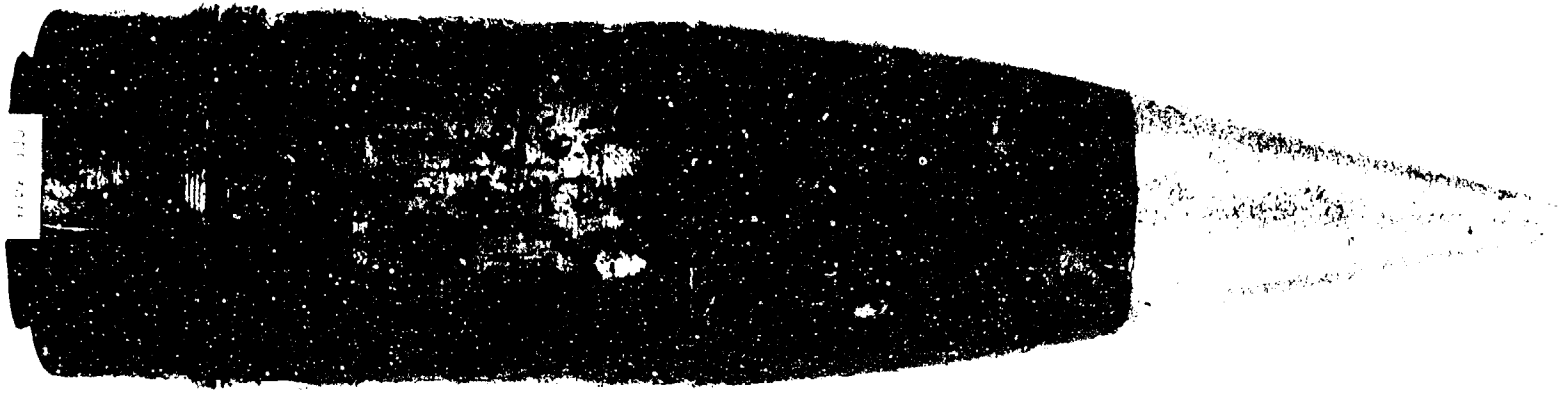

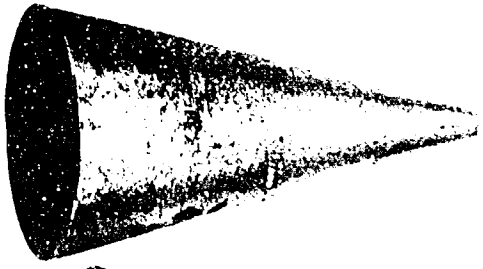

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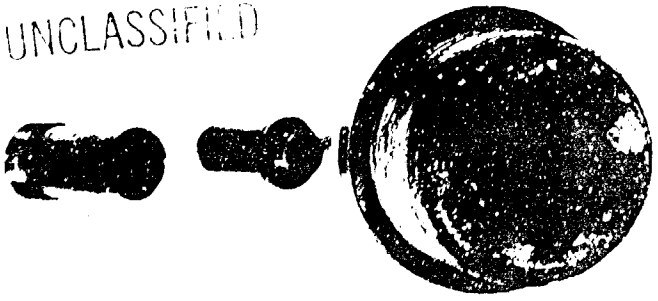
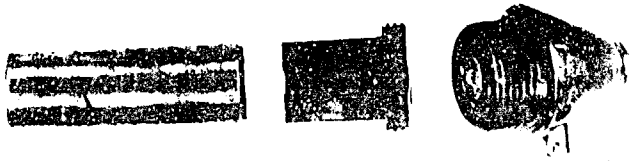
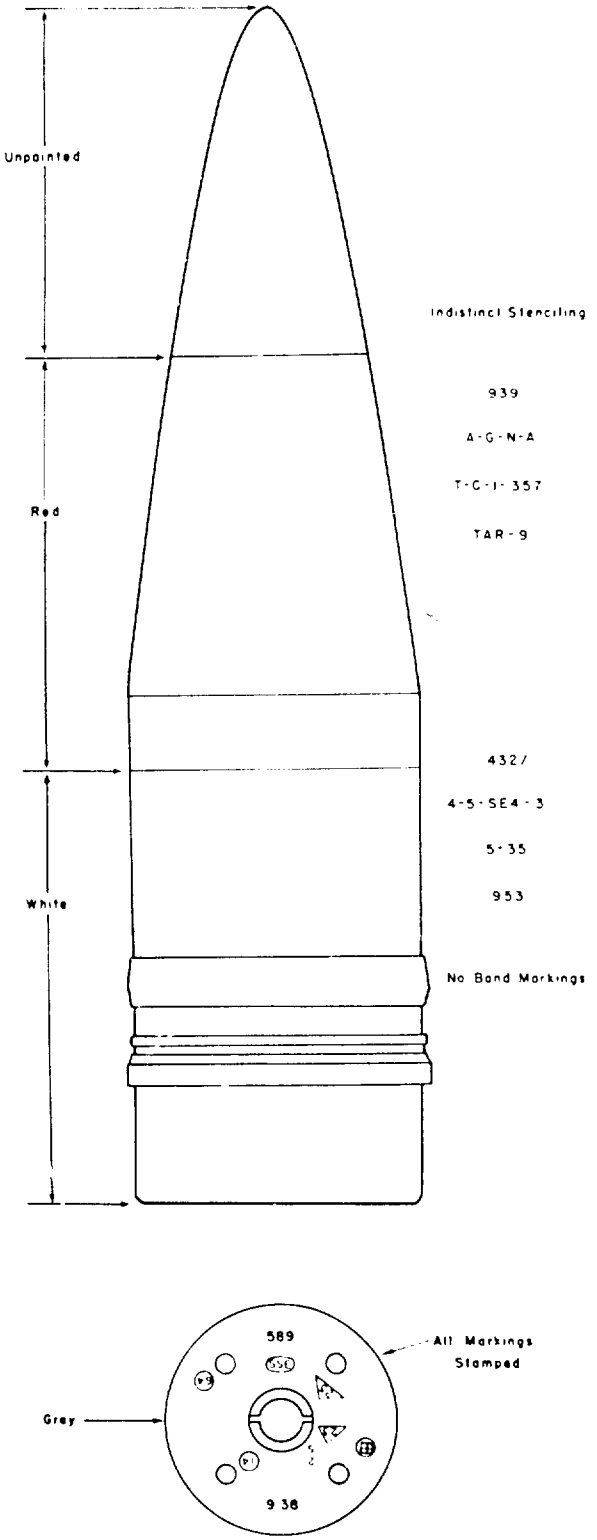




MARKINGS ON ITALIAN
6" HE PROJECTILE



NPG Photo No 2556 (APL)
May 15, 1945

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UNCLASSIFIED

I. INTRODUCTION

One Italian high explosive 6" projectile was examined. The following is a report of this examination, in accordance with the directive.

II. EXAMINATION

PHYSICAL

Figure 1 shows the projectile as received and disassembled. The projectile body is threaded at the nose internally to receive the point detonating fuze and externally to receive the cast aluminum windshield. A massive base plug is secured in the base of the projectile by means of "V" threads. This base plug carries an internal tracer. Immediately behind the point detonating fuze, which is of the impact type, is a flash tube also threaded to the projectile body. The flash tube, made of plastic with cloth filler, leads to the booster enclosed in a brass can which apparently was inserted into a cavity in the explosive filler.

The projectile was provided with two rotating bands located respectively 2-1/8" and 3-7/8" from the base. These bands were securely attached to the body in the conventional manner.

An unusual feature is the fact that the fuze is covered by the windshield. The fuze is made of brass, and was made bore safe by a clock escapement calculated to delay the arming. It appeared to be of the nondelay type.

The details of painting and marking are shown in Figure 2. For the most part stenciling was indistinct.

CHEMICAL ANALYSIS

The chemical analyses of the important components are given in Table A. Steel analyses are spectrochemical except for carbon, phosphorus, and sulfur which were obtained by the usual wet chemical methods.

The projectile body and base plug analyses are similar to those of SAE-1035 and SAE-X 1050 respectively.

The aluminum windshield has a composition approximating that of Alcoa Alloy 47, a sand casting alloy. The 12.5% Si alloy is used extensively in Europe.

The rotating bands on this projectile are made of copper which is impure compared to that used in American practice.

Figure 3

NPG PHOTO NO. 2558 (APL)
Bottom View and Deep Etched Section of Base Plug From Italian 6" HE Projectile CEE No. 3435.
15 May 1945 -[redacted]

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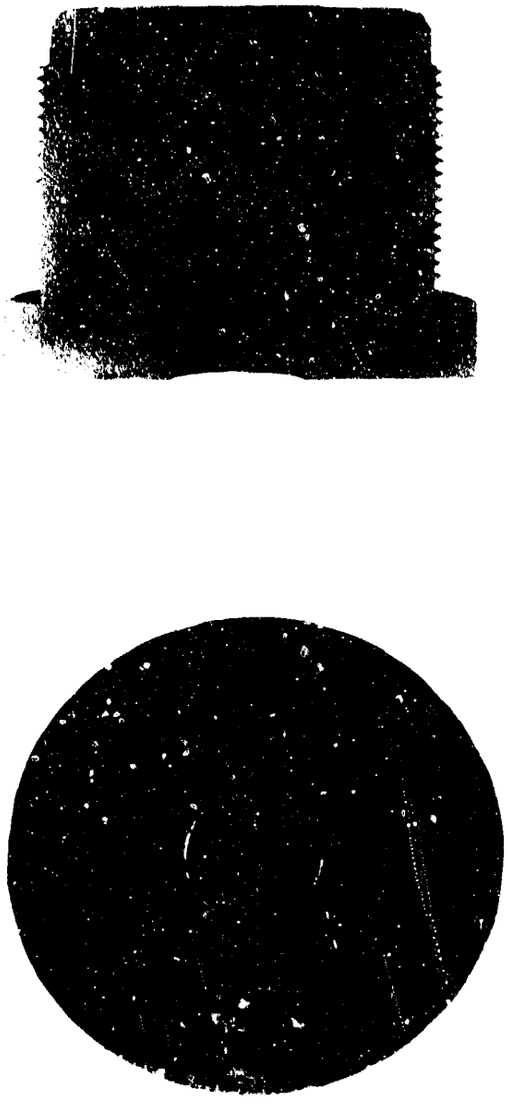

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Figure 4

NPG PHOTO NO. 2561 (APL)
Deep Etched Section of Body of Italian 6" HE Projectile
CEE No. 3435.
15 May 1945

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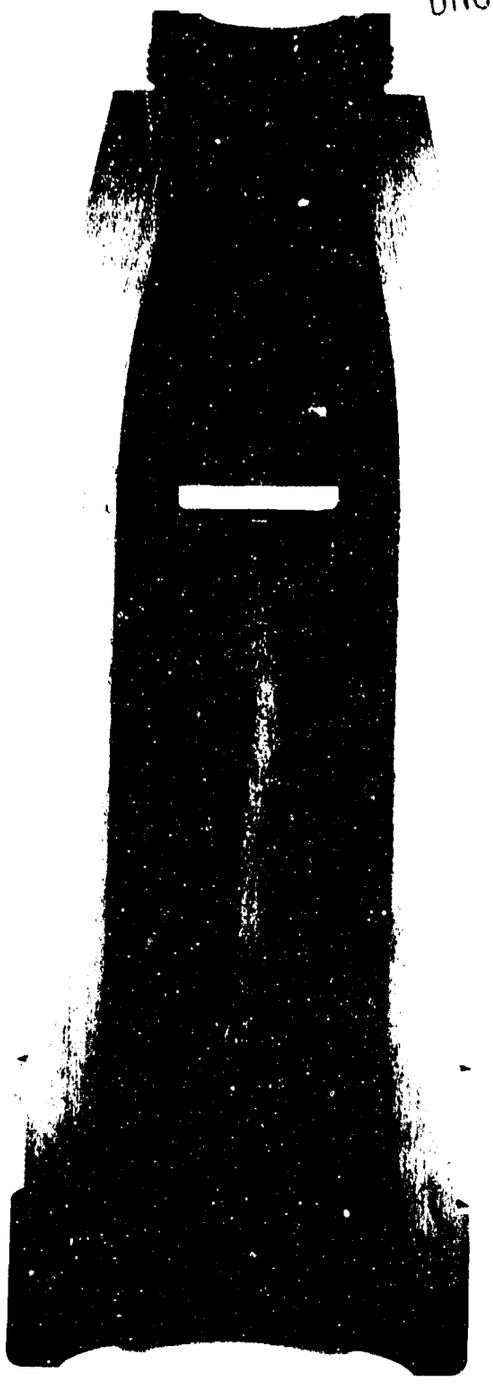
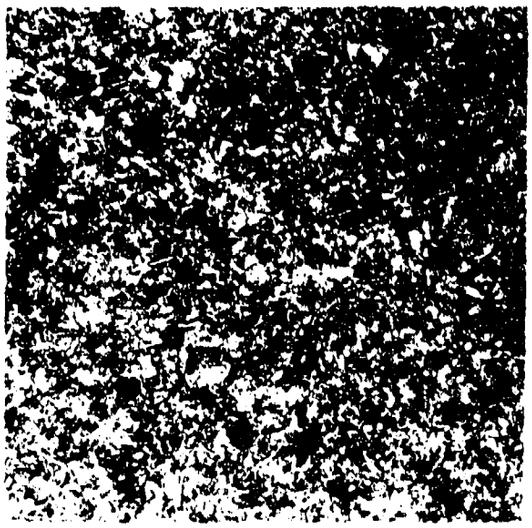


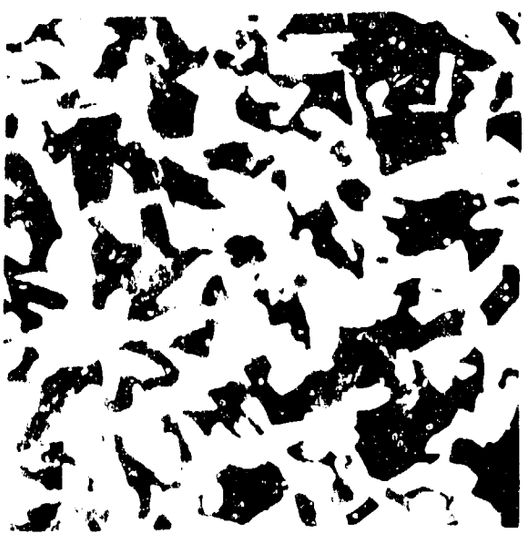
Figure 5

MICROSTRUCTURES OF ITALIAN
6" HE PROJECTILE



BODY Pearlite and Ferrite

Hardness: 260 VPN
Magnification: 250 X
Etch: Picral
M522



BASE PLUG Pearlite and Ferrite

Hardness: R_B77
Magnification: 250 X
Etch: Picral
M523

NPG Photo No.2564 (AFL)
15 June 1945

[redacted]

The deep etch pattern of the base plug and body are shown in Figures 3 and 4 respectively. The etch pattern of the projectile body shows flow lines indicating that this piece was forged. A small amount of upsetting is noted at the mouth of the cavity. The etch pattern of the base plug indicates that this piece was machined from bar stock.

The projectile body was sectioned and a hardness survey made. Its hardness was found to be uniform from nose to base. The hardnesses of the principal components are given below:

Body:	260 VPN
Base Plug:	7? Rb
Rotating Bands:	48-1/2 Rb

Figure 5 illustrates the microstructure of the body and base plug. Both structures consist of pearlite and ferrite. The fineness of the pearlite and the small amount of pro-eutectoid ferrite in the microstructure of the body suggest that this piece was quenched and tempered. This treatment did not result in high hardness since this steel has low hardenability. The microstructure of the base plug is a typical normalized structure.

The probable steps in the manufacture of this projectile are given below as far as is possible, consistent with the above information:

Body:
- a Forging
- b Quench. This may have been from the finish forging temperature or a separate operation.
- c Low temperature draw (stress relief)
- d Machining

Base: Machined directly from normalized bar stock.

III DISCUSSION

This projectile is probably effectively used against any target offering little resistance to penetration. The presence of an instantaneous point detonating fuze precludes the use of this projectile for penetrating armor, concrete, or earthworks. The microstructure of the body and base plug is not satisfactory for the effective penetration of armor plate.

VII
EXAMINATION AND BALLISTIC TEST OF ITALIAN 6" COMMON PROJECTILE CEE NO. 3438

SUMMARY

Metallurgical data and chemical analysis of the principal components of this projectile are presented together with the probable method of manufacture of the body and base plug.

Results of ballistic tests are presented which show this projectile to be of very poor ballistic quality.

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Fig. 6	NPG Photo No. 2691 (APL) Ballistic Test vs 2"4 STS Plate	3
Fig. 7	NPG Photo No. 2692 (APL) Ballistic Test vs 0"98 STS Plate.	3

Table A: Chemical Analyses

Figure 1

NPG PHOTO NO. 1403 (APL)
Italian 6" Common Projectile, CEE No. 3438, as Received and Disassembled View.
15 May 1945

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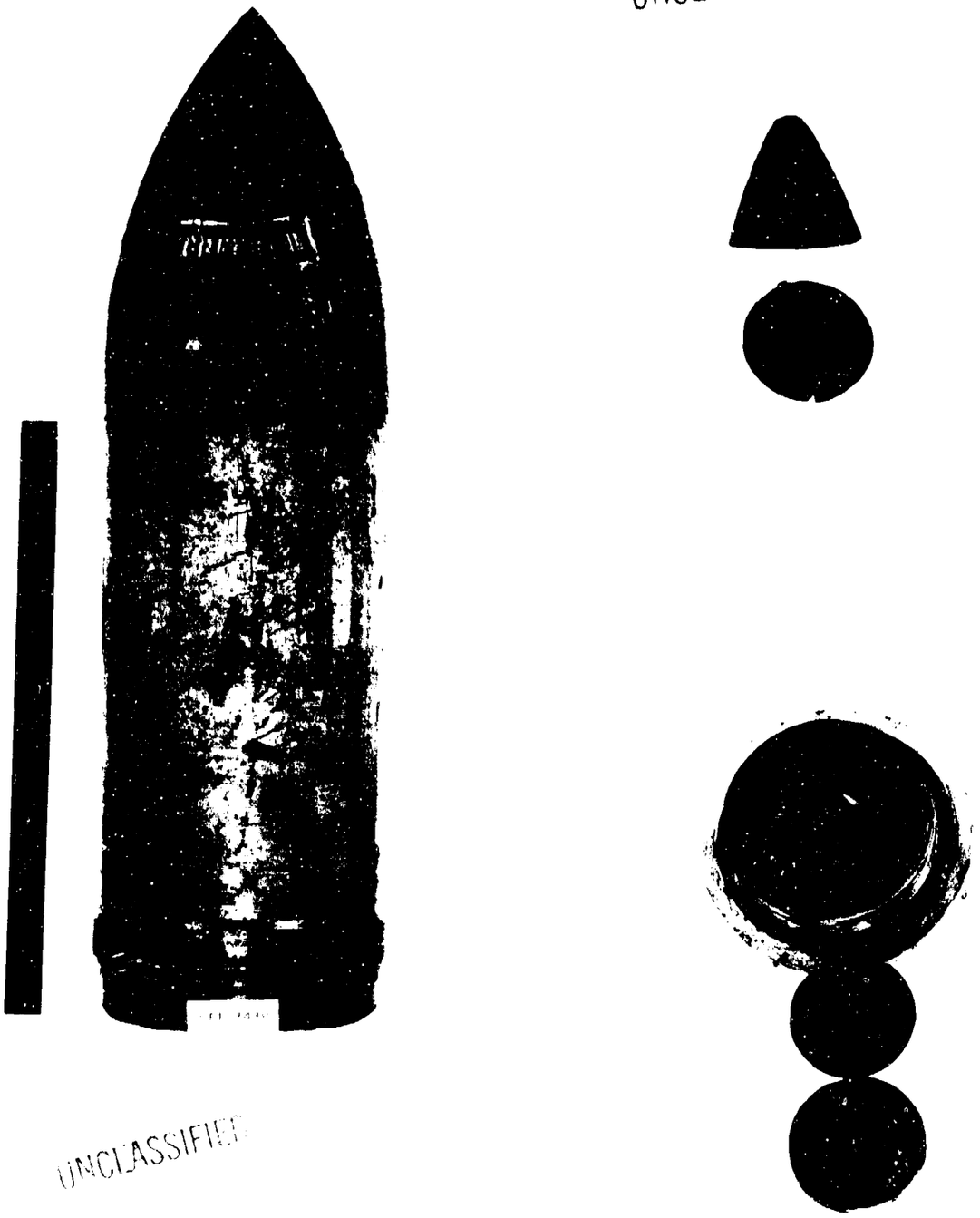

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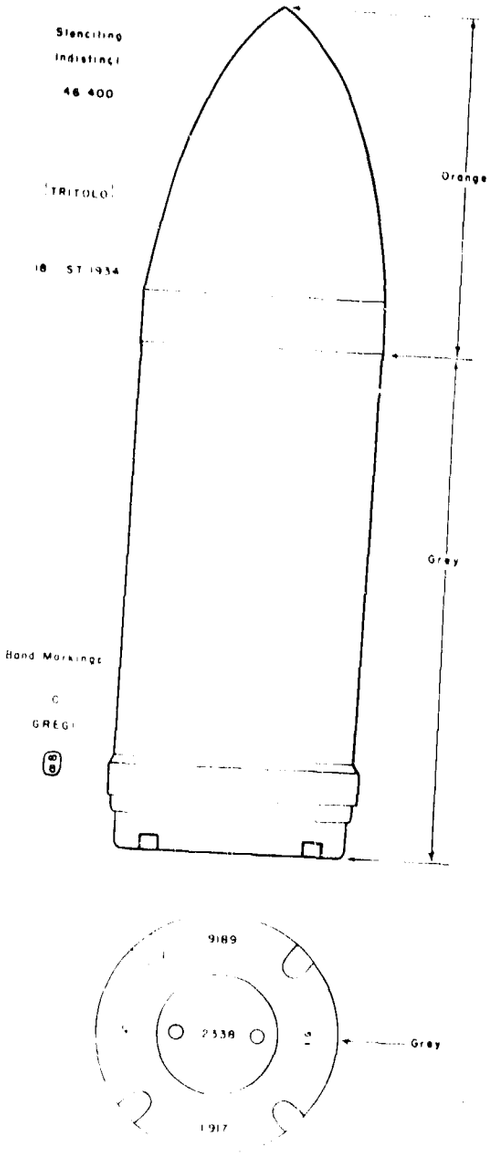
Figure 2

MARKINGS ON ITALIAN 6" COMMON PROJECTILE

CEE 3438



Markings on Body of Projectile are Stenciled
Band and Base Markings are Stamped

NPG Photo No. 2560 (APL)
May 15, 1945

Figure 3

NPG PHOTO NO. 2557 (APL)
Bottom View and Deep Etched Section of Base Plug from Italian 6" Common Projectile, CEE No. 3438.
15 May 1945 -[redacted]

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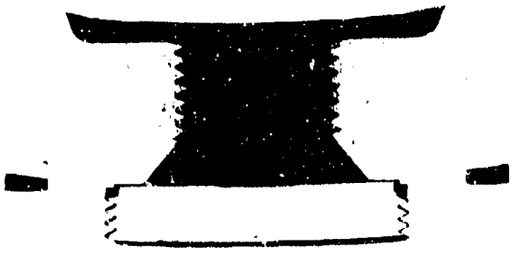

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Figure 4

NPG PHOTO NO. 2562 (APL)
Deep Etched Section of Body of Italian 6" Common Projectile, CEE No. 3438.
15 May 1945

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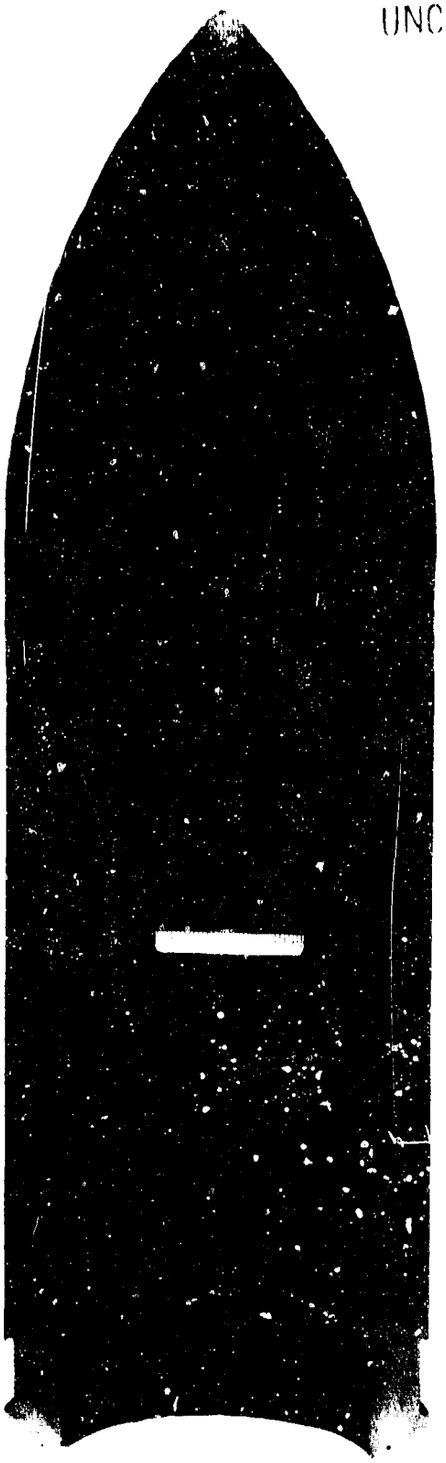


Table A

CHEMICAL ANALYSES OF ITALIAN 6" COMMON PROJECTILE COMPONENTS

	C	P	S	Si	Mn	N	Cr	Cu
Body	.33	.034	.046	.21	.89	<.08	<.08	.12
Base Plug	.55	.032	.051	.26	.92	<.08	<.08	.09

	Cu	Sn	Fe
Rotating Band	99.97	.023	.007
Sealing Ring	99.95	.03	.02

	Pb	Sn	Trace
Lead Sealing Ring	99.90	.068	Cd, Ag
Lead Sealing Disk	99.96	.034	Sb,Bi,Ag

I. INTRODUCTION

One Italian 6" Common projectile was examined and two of the same type were tested ballistically. The following is a report of the examination and of the ballistic tests in accordance with the directives. Although the directive lists this projectile as an AP, upon examination it was evident that it was a common projectile and this designation is therefore used.

II. EXAMINATION

PHYSICAL

This projectile is shown as received and disassembled in Figure 1. The projectile has no hood or windshield. The base plug is unique in that its outer edge forms the contour of the base end of the projectile. The base plug is threaded to take a base detonating fuze which in turn is protected from the propellant gases by a small disk screwed into the base plug behind the fuze. A wooden plug shaped to fit the forward end of the cavity and a felt-like pad are provided to act as a cushion for the explosive filler.

A single rotating band 1-1/4" from the base was securely attached by the conventional means.

All stenciled and stamped markings are indicated in Figure 2 which also indicates the painting. The stenciling was indistinct.

CHEMICAL

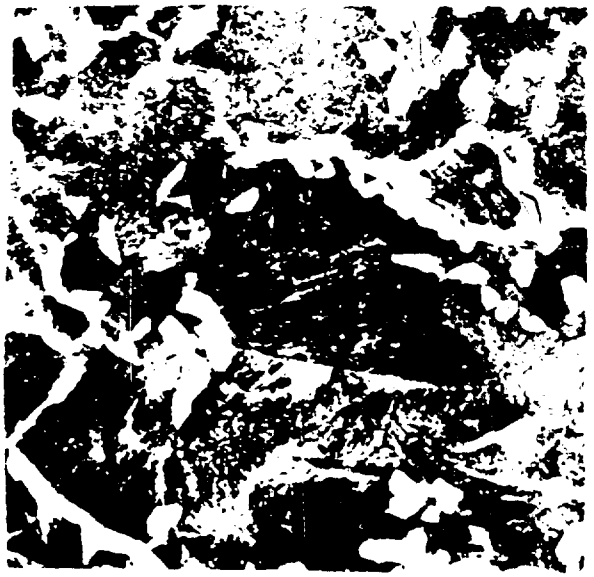
The chemical analyses of the important metallic components are given in Table A. The analyses for steels were determined spectro-chemically except for the elements carbon, phosphorus, and sulfur, which were determined by the usual wet chemical methods.

The projectile body and base plug analyses are similar to those of SAE 1035 and SAE X 1055 analyses respectively. The copper in the rotating bands is of a purity comparable to that of American rotating bands. The sealing ring is also made of high purity copper.

The etch patterns of the base plug and of the body are shown in Figure 3 and 4 respectively. Both of these pieces show flow lines resulting from forging.

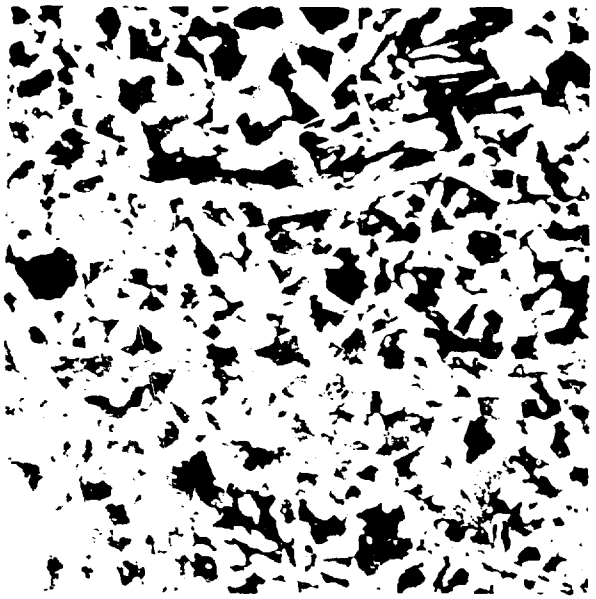
Figure 5

MICROSTRUCTURES OF ITALIAN
6" COMMON PROJECTILE



BODY Pearlite and Ferrite

Hardness: 200 VPN
Magnification: 250 X
Etch: Picral
M520



BASE PLUG Pearlite and Ferrite

Hardness: R_B 85
Magnification: 250 X
Etch: Picral
M521

NPG Photo 2563 (APL)
15 June 1945

The projectile body was sectioned and a hardness survey made. The hardness was found to be uniform. The hardnesses of the principle components are given below:

Body:	200 VPN
Base Plug:	R_B 85
Rotating Band:	R_B 27

Figure 5 shows the microstructure of the body and base plug. The body consists of coarse pearlite and of ferrite which is decidedly an undesirable structure ballistically. The base plug consists of pearlite and ferrite finer than that of the body. These are normalized structures.

The probable steps in the manufacture of this projectile are given below insofar as is consistent with the above information.

Body and Base Plug.

a. Forging
b. Normalizing
c. Machining

III. BALLISTIC TESTS

Two rounds were tested ballistically. The first round was fired against 2-1/2" STS plate at 30° obliquity at a velocity about 10% above the limit velocity of average STS plate vs 6" common projectile Mk.27-7. This round was rejected by the plate completely broken up. Since nothing of value could be learned from further firing under these conditions, the second round was tested against 1" STS plate at 30° obliquity at a velocity greatly in excess of the plate limit. This round penetrated the plate and was effective with the tip of the nose chewed and the ogive gouged. The Mk. 27-7 projectile will remain effective and intact after penetrating considerably more than 2-1/2" STS at 30° obliquity. The test conditions of round 1 are less severe than the acceptance test conditions of the Mk. 27-7 projectile.

NPG PHOTO NO. 2691 (APL). Ballistic Test of Italian 6" Common Projectile

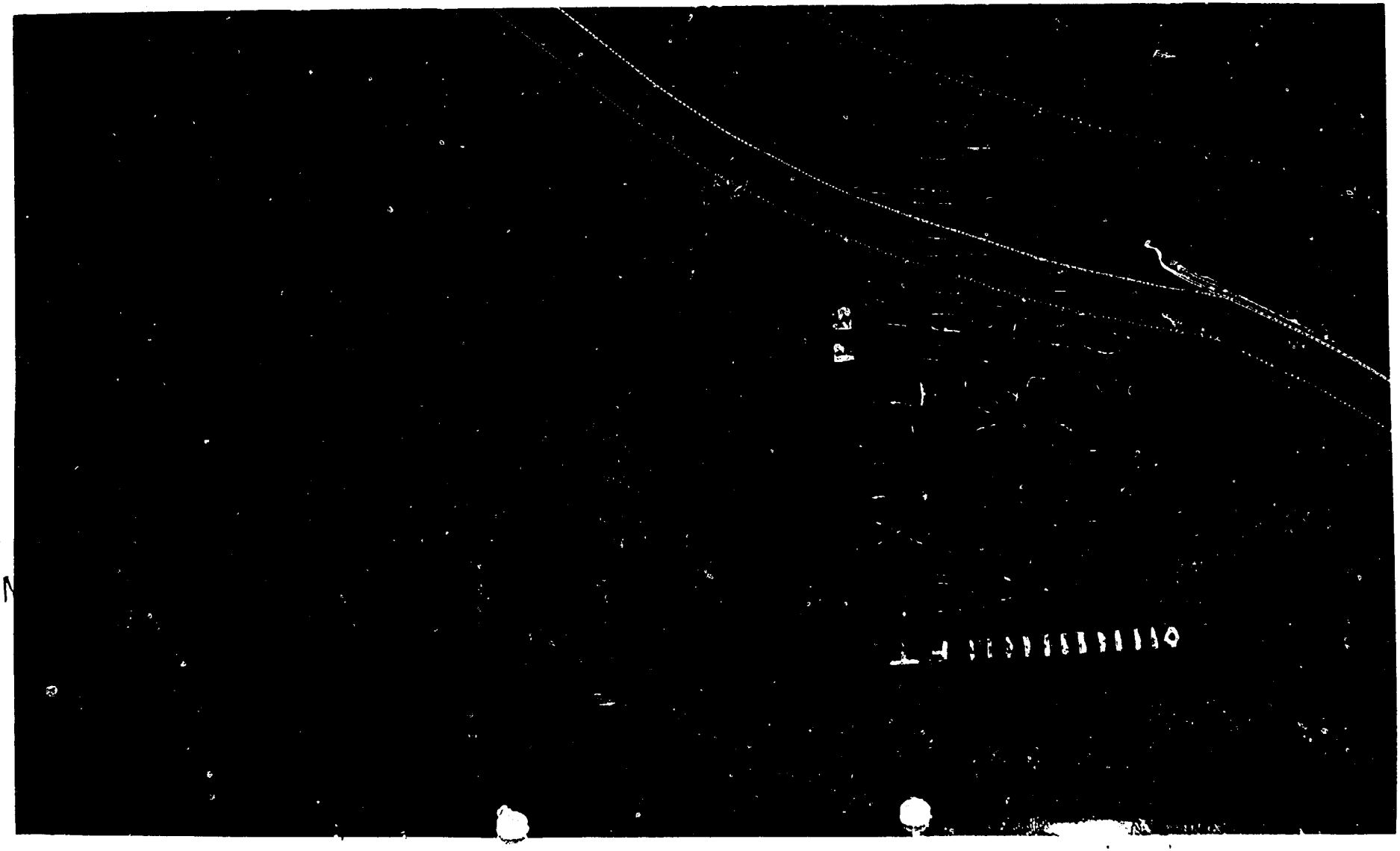
Impact No.	Plate Thickness	Obliquity	Striking Velocity	% of SK78841	Penetration	Remarks
30720	2".40	31°-20'	1052 ft/sec.	112.5	1/2"	Projectile completely broken up.

3 March 1945

UNCLASSIFIED

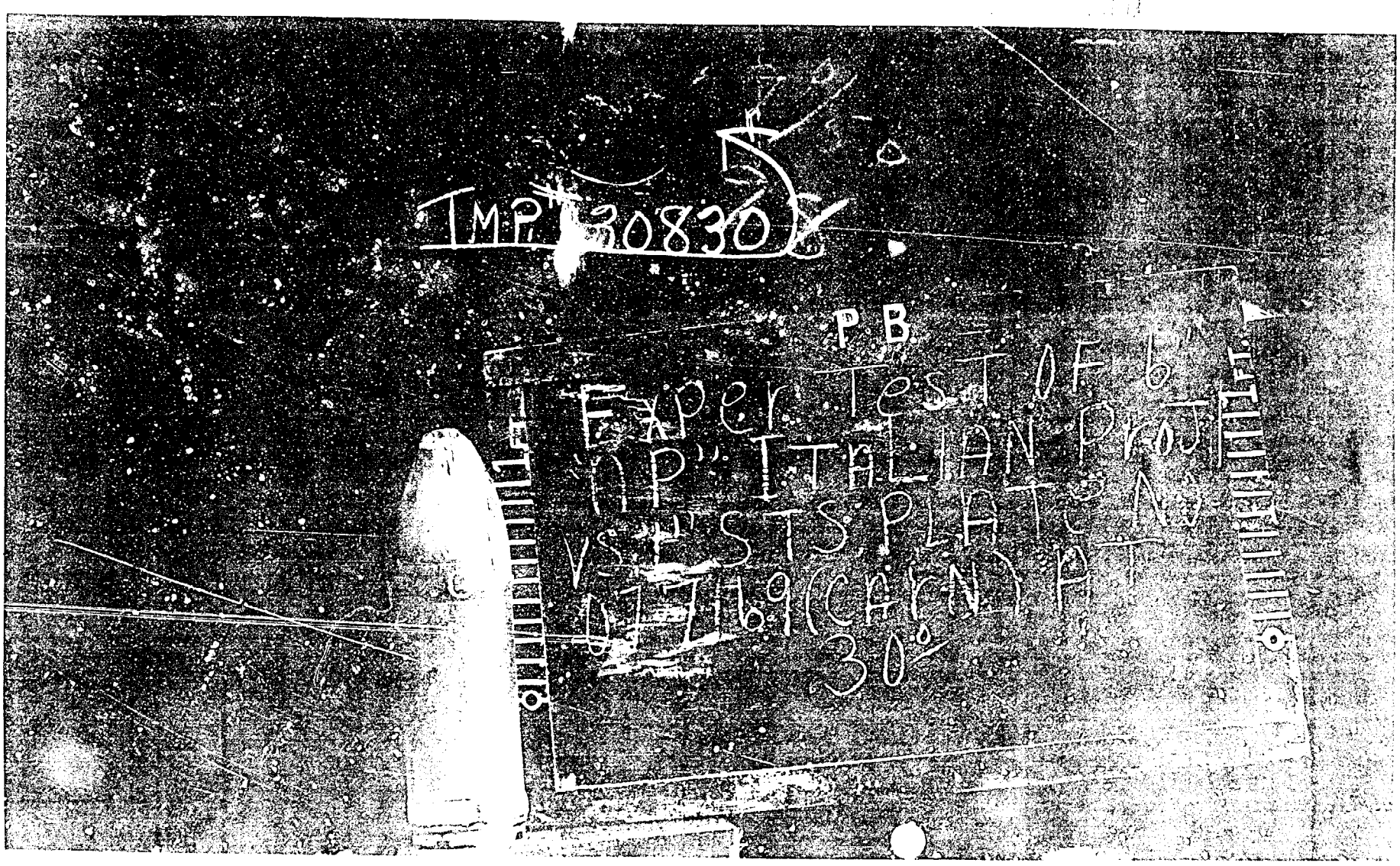
[redacted]

UNCLASSIFIED



Impact No.	Plate Thickness	Obliquity	Striking Velocity	% of SK78841	Penetration	Remarks
30830	.98	29°50	1053 ft/sec.	198.8	complete	Projectile effective nose chewed and ogive gouged.

15 March 1945



Details for the ballistic tests are given below. Photographs of the projectiles and plates after impact are shown in Figure 6 and 7.

	Round 1	Round 2
NPG Impact No.	30720	30830
Plate Thickness	2".40	0".98
Obliquity	31°20'	29°50'
Striking Velocity	1052 ft/sec	1053 ft/sec
% of Sk.78841	112.5	198.8
Penetration	1/2"	Complete
Dish	1/2"	1"
Impact Dimensions	3" x 5"	6" x 10"
Thru Opening	None	6" x 9-1/2"
Proj. Condition	Completely broken up	Eff., Nose chewed, ogive gouged
	Projectile Wt. 119#, Inert Filler	

IV. DISCUSSION

The ballistic test shows this projectile to be greatly inferior to U.S. Navy 6" Common projectiles. After penetrating a 1" STS plate at 30° obliquity the Italian projectile had its nose chewed and the ogive gouged. This poor performance is due to two factors,

1. Inferior microstructure. Coarse pearlite and ferrite is a very undesirable structure when resistance to shock is desired. A microstructure of tempered martensite, necessary in order to obtain good ballistic performance, could not be obtained, in a projectile of this size with the plain carbon steel used.

2. Low hardness. Modern U.S. Navy common projectiles have a differentially hardened body with a nose hardness of from 600 to 620 VPN. The whole body of this Italian projectile is softer than the base of the U.S. Navy common projectile.